

# Aviation Week & Space Technology

February 4, 1963

SPECIAL REPORTS:

Thin-Film Survey  
•  
Navy Integrated  
Maintenance

75 Cents

A McGraw-Hill Publication

Pershing-Chinook Compatibility Test



## The Honeywell Visicorder oscillograph & GUNPOWDER records forces in circuit breaker bushings

When forces imposed by the explosion of elliptical circuit breakers—especially during short-circuit interruptions—are disruptive enough to damage bushings, Engineers at the Ohio Brass Company have devised an ingenious method of visualizing the explosive forces in order to analyze bushing tests.

On a typical bushing, they mounted a dummy accelerometer, in which they exploded gunpowder to propel from the interrupter fire-damped metal projection. Strain gages, installed on the bushing spread sleeve, were connected to a Honeywell Model 100 Visicorder.

A Honeywell 100 Visicorder oscillograph was chosen to record the load data because of the exceptionally high speed and transient nature of the signals to be recorded.

A typical record of this test, shown at right, was made at a record speed of 30" per second.

These Ohio Brass tests have opened the way to the development of standards for the mechanical performance of bushings (ASTM papers G2-153, G2-301).

This application is only one of thousands where the Visicorder is called upon daily as a basic research, test, and development tool. One of the six different Visicorder models should be a basic requirement in the management of your data requirements.



Record of vibration activity. Two different tests are recorded on one strip of film. Possible a continuous vibration of gages in testing unit. It is shown at a test of bushing, as in all right, which test for electrical energy producing stresses from dynamic vibrations. Honeywell Model 100 Visicorder Oscillograph records circuit breaker bushing test for this test.



For full details on all Visicorder Oscillographs, tape systems, and signal conditioning equipment, write to Honeywell, Division, Des Moines, (Des Moines, Iowa), or Honeywell, 300 1st St., Minneapolis, Minn. 55401.

**DATA HANDLING SYSTEMS**

## Honeywell



The Honeywell Model 100 Visicorder Oscillograph—with a Honeywell Model 100 Amplifier—can record bushing test for this test.

## Capability Means Product Improvement

ORIGINAL DESIGN REQUIREMENT

**560 hrs.**

(Time Between Overhauls)



PRESENT CAPABILITY

**3000 hrs.**

(Time Between Overhauls)



## Backed by 3,500,000 Hours of Turbine Powered Airline Operation

Pump overhaul life expectancy has jumped to 3000 hours on airlines operating Boeing 707s and 737s or Convair 440s and 580s. At the time

commercial jetliners entered service, this pump's 560 hour overhaul life was the best available. Now—Vickers planned product improvement program has produced a nearly 400% improvement in "time between overhauls" in the same package—again the best in its field.

One phase of this planned program concentrated on improving bearing life. It included: 24,231 test hours on jets operated by eight major domestic and foreign airlines, 23,126 hours of pump endurance testing, and 310,440 hours of accelerated bearing testing—a total of 387,797 hours. New bearings developed play a big part in longer life between overhauls and higher reliability.

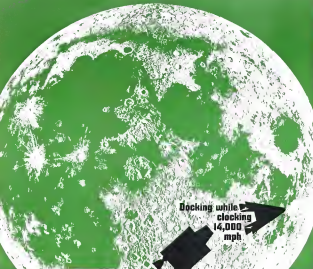
To maintain leadership in fluid power systems for aerospace applica-

tions, Vickers close liaison with airlines, airlines manufacturers and engine builders. Through the knowledge gained from application engineers and service technicians, specialized schools and company-sponsored conferences, Vickers maintains a continuing flow of new and improved products for changing aerospace requirements.

**MORE DATA AVAILABLE—** Write for Bulletin A3283 "Harnessing Fluids for Airframe Use" to: Vickers Incorporated, P.O. Box 332, Troy, Michigan.



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**OPTICAL ELECTRONICS** Space rendezvous problem: how to align for physical coupling of vehicles orbiting at predicted speeds of 14,000 miles per hour? Answer: Kollsman power optics guidance systems with accuracy potential of one part in 100,000 miles. □ Other Kollsman optical electronic programs currently in progress include improved integration of celestial navigation systems with pilot controls in manned space vehicles . . . altimeter optics for orbiting solar observatories . . . and approach-pattern recognition techniques for vehicle guidance to planetary landings or space rendezvous.

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**Kollsman Instrument Corporation**

MEMBER OF THE NEW YORK UNIVERSITY OF MANAGEMENT AND TECHNOLOGY, INC.

## AEROSPACE CALENDAR

- Feb. 11-15**—Third International Symposium on Quantum Electronics, UNESCO Building, Paris. France. Sponsors: International Scientific Radio Union, Office of Naval Research, La Federation Nationale Des Laboratoires Electroniques.
- Feb. 12-15**—Space Vehicle Thermal and Airplane Control Symposium, cosponsored by the American Astronautical Society, Eastern Club Dayton, Ohio. Sponsors: VDT Flight Aeronautics Laboratory.
- Feb. 18-19**—Hydrodynamic Simulation and Space Test, Congress and Conference, European Park, San Paolo, Italy.
- Feb. 18-21**—Space Shuttle Design Conference, Feb. 18-21-1969 International Solid-Rocket Cruise Conference, Philadelphia, Pa. Sponsors: Institute of Electrical and Electronic Engineers, University of Pennsylvania.
- Feb. 18-21**—Western Region Conference American Society for Quality Control, Pioneer Hotel, Las Vegas, Nev.
- Feb. 26**—Mar. 1-1970 Annual Technical Conference, Society of Plastic Engineers, Santa Monica Hotel, Los Angeles, Calif.
- Feb. 28**—Mar. 1-2—Cosmos-1 Conference, Reading Conference, Sheraton Hotel, Philadelphia, Pa. Sponsors: Eastern Air Force, Bureau of Naval Affairs.
- Mar. 31**—Security, Annual Conference, Cato Center, Arlington and Space Meeting, American Society of Mechanical Engineers, Sheraton Hotel, Los Angeles.
- Mar. 6-7**—Data File Symposium, Hollywood Sheraton Hotel, Hollywood, Calif. Sponsors: Information, Inc.

(Continued on page 7)

## AVIATION WEEK & Space Technology

February 4, 1962  
Vol. 20 No. 2

AVIATION WEEK AND SPACE TECHNOLOGY is a unique publication that provides the aerospace industry with a comprehensive survey of the latest developments in the field of aviation and space technology. The magazine is published weekly and is available to all subscribers. It is a must-read for anyone interested in the latest news and developments in the field of aviation and space technology. The magazine is published by AVIATION WEEK & SPACE TECHNOLOGY, Inc., and is available to all subscribers. It is a must-read for anyone interested in the latest news and developments in the field of aviation and space technology. The magazine is published by AVIATION WEEK & SPACE TECHNOLOGY, Inc., and is available to all subscribers. It is a must-read for anyone interested in the latest news and developments in the field of aviation and space technology.

AVIATION WEEK AND SPACE TECHNOLOGY, Inc. is a leading publisher of aviation and space technology magazines. The company is located in New York, New York, and is a member of the National Association of Publishers. The company is also a member of the International Association of Business Editors and Publishers.



What  
is  
this  
tape's  
code  
format?



whatever you tell it!

Frident Flexowriter® prints the sort of 3, 6, 7 or 8-channel tape such of which is processed with a standard tape code. The 8-channel type permits heavily loaded channel coding of the message and provides the added facility of purely checking that the Flexowriter's message is correctly stored there. It is draped with a reading and processing unit that gives you almost unlimited flexibility of code format.

For instance, Flexowriters are used in pattern recognition research. In that pattern recording is possible type is born correctly inside by using other mechanisms of X and Y coordinates of every pattern detail recorded.

The Flexowriter's code format flexibility permits almost any type of control data propagation and tape listing in the service of closed-loop control systems. Further, since it can receive from transmitters, both

digital and analog data, in a form that can be manipulated and controlled by other machines, the Flexowriter is available as an integral part of many new control systems.

As ability to act as a detector and demodulator with excellent adaptability of format, makes of apparent the applications of the Flexowriter in problems of control design and operation are limited almost solely by the limits of the imagination.

To fully investigate the Frident Flexowriter, call your local Frident representative or write: Frident, Inc., San Francisco, California. TIME IS PRACTICALLY practical information by Frident—for business and industry.

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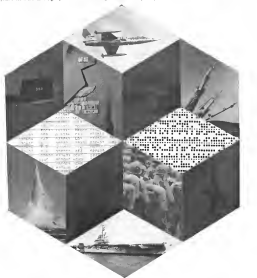
the costly, complex weapons systems of today make such a decision far more difficult than in the past. World-wide threats and events are frequently involved. The time for decision has been compressed, the information on which it must be based has been multiplied in volume, variables, interrelationships. This new era of decision-making has led commanders and governmental leaders to make use of man-machine systems which provide information processing assistance. DDC's staff of scientists, engineers and computer programmers have been developing these inner systems for more than eight years.

They help develop the system itself, and the hardware within the system. Specifically, they analyze system requirements, synthesize the system, construct computers which are the core of the system, man the system, evaluate the system, adapt it to the changing needs of its users. And in so doing, they consider the interaction and effect of men, decisions, machines, planning, of organizations, chains-of-command and chain-of-succession, of communications, traffic centers, command posts, computers and displays. Human factors scientists operate on research across systems: personnel, equipment and computer performance.

examines interested in joining this rapidly expanding field and working in a close interdisciplinary effort are invited to meet Dr. M. E. Ebel, IDC, 2482 Colorado Ave., Santa Monica, California. Postages are open at IDC facilities in Santa Monica, Washington, D. C., Lexington, Massachusetts, Paramus, New Jersey, and Dayton, Ohio. We read enthusiastically reviews



**System Development Corporation**  
Systems that help men make decisions and  
execute complex



(Continued from page 7)

Mar. 6-8—Annual Meeting, American Cellulose Ass'n, Packaging Division, Bost., by APF. Also Hosts Air Force Packaging Laboratory, Mobile Air Materiel Assn.

Mar. 7-6—Propulsion Meeting, IAS/NAAB, Cleveland, Ohio.

Mar. 11-15—Electrical Propulsion Conference, American Rocket Society, Bradenton Hotel, Collier County, Fla.

**Mar. 18-20—Space Flight: Testing Center**  
 on, American Rocket Society and Institute of the Aerospace Sciences, Cocoa Beach, Fla.

May 18-23—1953 Western Metal Exposition and Congress, Pan-Pacific Auditorium/ Ambassador Hotel, Los Angeles  
May 18-22—Survey National Convention

May 1921—Second Air Force organized  
headquarters at Boston, Belmont Hotel

May 15-16—International Convention, Institute of Electrical and Electronic Engineers, Waldorf Astoria and Colonnade, New York, N.Y.

May 25-29-1986: International Symposium on Electron Beam Technology, Sheraton Sheraton Place, Cambridge, Mass. Sponsored by Allied Electronics Corp.

Apr. 13—Launch and Space Vehicle Shell Southern Conference, American Institute of Aeronautics and Astronautics, El Segundo, Calif., El Segundo Golf Club.

Apr. 24-25th Annual Business Aircraft Safety Seminar, Flight Safety Foundation, Bethesda Plaza, New York, N.Y.

Apr. 25—Spring Candidates, Airport Operator Council, Sheraton Hotel, Washington, D.C.

Apr. 27—Third Annual Air Transport Ex-

John J. Schmitt, Director of Communications and Public  
 Policy, New York University's Division  
 of General Education, NYU, 100 Washington Square,  
 New York, NY 10003-4242, USA  
 Tel: +1 212 998 4600  
 Fax: +1 212 998 4600  
 E-mail: jjschmitt@nyu.edu

Apr. 18-19—Fourth Symposium on Engineering Aspects of Magneto-hydrodynamics, University of California, Berkeley.

Age 16.13—Optical Music Recognition  
United Engineering Center, New York,  
N.Y. Sparsity: Faltstichs Institute of  
Brooklyn, Institute of Electrical and Elec-

Apr. 17-19—Annual Technical Meeting and Equipment Exposition, Institute of En-

Age 17-18, International Nonlinear Mechanics (INTERMAG) Conference, June

Int. of Electrical and Electronics Eng.  
apex, Sheraton Hotel, Washington  
Apr. 12-19—Southwestern Conference and  
Electronic Show, Institute of Electrical

Apr. 15-19: Technical Meeting Nuclear Materials for Space Applications, Amer-

(Continued on page 54)

A good way to maximize logic in applying existing capabilities to the solution of new problems is to start applying them before the problems exist. This is not a ploy on words, nor a speculation of future time, but a highly workable concept containing much food for thought—as the members of Build Electronics/ADAPT group will be glad to demonstrate.

ADAPT, which means Advanced Development and Planning Center, starts with the realization that it's often no simple matter to put capabilities to work today. Our most urgent problems can be solved only by approaches that cut across the lines of many disciplines. Developing such approaches lies within the confines of a single capability is undeniably difficult. The view must be broader, and that's where ADAPT comes in.

The work of our ADAPT group is based on the conviction that planning—the kind of planning it takes to adapt and integrate today's fast-moving technologies to meet new needs—is no staff's job.

This kind of planning calls for reaching into an array of varied capabilities, selecting those that can contribute to the solving of the problem at hand, reorienting and reorganizing them toward that solution, and determining what new concepts and new capabilities must be developed if the solution is to be attained. In a very real sense, the total capability that results is more

Such planning calls for exceptional men—men like the specially assigned senior physicians and engineers of the ADAPT group. This group makes available an unusual depth and a complete range of experience in communication electronics—in point-to-point communications, detection systems, information systems (including resident doctors), guidance, telemetry, atmospheric and other related areas.

ADAPT men are themselves constantly adaptable. They can turn their skills with equal competence to applied research or systems design, to concept development or engineering planning. In sum, they excel at designing practical programs for bringing ideas to fruition.

ADAPT can and should be applied at the earliest possible stage of the game. If you have needs or communication deficiencies . . . or think you're going to have needs . . . you will find a discussion with the ADAPT group rewarding. You will speak immediately to knowledgeable people . . . determine the proper path for your program and have the required capabilities focused without delay. We will be glad to tell you more about ADAPT . . . and about the growing Budd Electronics capabilities it draws together. Write or call Mr. Robert O. Vogle, Director, ADAPT, Budd Electronics, 1815 No. First Street Dr., Arlington, Va. Phone 783-502-3792.

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AERIAL ELECTRONICS DIVISION  
DEFENSE PRODUCTS DIVISION  
NEW YORK, N. Y. 10077

## AEROSPACE CALENDAR

(Continued from page 7)

- Apr. 22-23—Annual Meeting, National Aeronautics Research Assn., Washington, D. C.
- Apr. 22-24—Second Annual Space Flight Symposium, IAS/ONAA, Vancouville Hotel, Pacific City.
- Apr. 22-24—Third Annual San Diego Symposium for Aeronautical Engineering, Del Webb's Qualicumbe, San Diego, Calif.
- Apr. 23-25—Biographic Roundtable Conference, American Rocket Society and American Society of Mechanical Engineers, North Dakota Laboratory, Wadsworth Hall, Minn.
- Apr. 29-30-1961 Spring Meeting, Western States Section/The Gas Institute Institute, Vacation Village, Mount San Diego, Calif.
- Apr. 29-30—General Dynamics/Aerospace Associates, 29th May 2-22nd Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton Johnson Hotel, St. Louis, Mo.
- Apr. 29-May 1—National Conference, Society of Photographic Scientists and Engineers, Ambassador Hotel, Midtown City, N. Y.
- May 13-14—Aerial National Forum, Western Helicopter Society, Sheraton Park Hotel, Washington, D. C.
- May 2—Aeronautical Conference, American Rocket Society and Aerospace Medical Assn., Los Angeles, Calif.
- May 23—Fourth National Symposium on Human Factors in Electronics, Institute of Electrical and Electronics Engineers, Sheraton Twin Bridges Hotel, Washington, D. C.
- May 24-26—1961 Annual Conference, American Assn. of Airport Executives, Golf Course Mkt. Beach Club and Condo Hotel, Norfolk, Va.
- May 24-26—Aerospace Reliability and Maintenance Meeting, IAS/ONAA/SAE, Washington, D. C.
- May 28-29—Electronic Components Conference, Institute of Electrical and Electronics Engineers, Sheraton Twin Bridges Hotel, Washington, D. C.
- May 28-29—National Aerospace Electronics Conference, Institute of Electrical and Electronics Engineers, Sheraton Hotel, Dallas, Texas.
- May 19-21—General Conference, General Flight Program, Second National Symposium on Air Transportation, Hartford, Conn.
- May 20-22—National Symposium on Microwave Theory and Techniques, Institute of Electrical and Electronics Engineers, Sheraton Hotel, Santa Monica, Calif.
- May 20-22—National Telecommunications Conference, Hilton Hotel, Albuquerque, N. M.
- May 21-23—Spring Joint Computer Conference, American Federation of Information Processing Societies, Colorado Hotel, Detroit, Mich.
- May 22-23—Sixth Annual National Conference on Product Engineering & Production Institute of Electrical and Electronics Engineers, Continental Hotel, Cambridge, Mass.
- June 7-8-21th French International Air Show, Le Bourget, Paris, France.
- June 19-20—Seminar Meeting, American Institute of Aeronautics and Astronautics (AIAA), Hotel Ambassador, Los Angeles.



## No other switch package can stand such vibration

**Strong claim?** Yes! But we've been told that the KLIXON® AT-28 Switch Package has the most vibration resistance that the most basic thing.

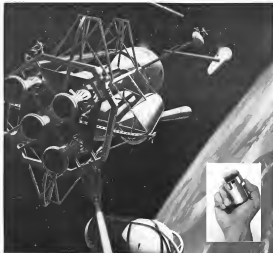
**The test?** Random variable at 570's 0-2000 cps vibration... the most severe test any switch package has ever been asked to pass. Yet, AT-28 performs throughout the test without critical interruption of its 5-amp load. It must pass the test because its function is to indicate the position of propellant valves in one of our new solid missiles.

**The switch?** Inside this rugged package is the smallest hermetically sealed snap-acting switch in the world. The KLIXON AT-1... reliability-proven in switch packages in many missile, satellite, aircraft applications. Weight—less than a gram. Ambient temperature range—65° to 275°F. Shock resistance: 200G's. Operating life: 25,000 cycles. In addition, this package that indicates the switch has age-lasting properties and is environment free. Bulletin PRSW-11 gives all the facts.

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## Project Cap Pistol

"Cap Pistol", a subminiature rocket motor, is as simple as its nameake in concept — and even smaller in size. Developed for the US Air Force by the Wright Aeronautical Division of Curtiss-Wright, it is a space vehicle control system designed to guide spacecraft precisely on course during flights outside the earth's atmosphere.

Cap Pistol fires bits of solid propellant, each on individual rocket motor, to make possible controlled pitch, yaw, and roll in outer space—where the mere force of a whisper can maneuver a multi-ton spacecraft.

A new concept in rocket propulsion systems, Cap Pistol is by far the most reliable yet devised for a variety of space applications. Cap Pistol can be stored anywhere in a space vehicle without regard to provocation or time lapse—and offers a zero-ignition capability for days, months, years.

**Cap Pistol** is one of a series of advanced rocket engine projects being conducted by the Wright Aeronautical Division today, for the spacecraft of tomorrow. Information is available on request.

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## Why so many computer users prefer the Control Data 1604/1604-A ...and five reasons why it will pay you to know!

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system, Fruehauf produced the enclosures for the organizational and field maintenance test stations and the missile transporter. This entirely self-contained system can go wherever it is needed, set up, test and assemble the missile, fire it, and be on the road again—ready to deliver another lethal blow—all in a matter of minutes!

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in space...



disassembly



of 30 billion foot-pounds



of energy...



guidance



precisely through



the needle's eye

**Command Recovery.** Terminal control and landing of spacecraft, energy management, data links, cockpit displays for aerospace missions. These are not just "long-range objectives" at Sperry Phoenix. For example, we are under contract with USAF Aeronautical Systems Division to capture the X-30 Dym-Sear vehicle upon re-entry from space, then manage its de-orbit and landing. This will be done with Sperry microwave guidance and control equipment existing today. We believe we can excel in this USAF assignment because it represents a logical extension of years of Sperry Phoenix experience in high-performance pilotless flight...experience greater in depth and breadth than that of any other company. We welcome new challenges in these and related fields. **SPERRY PHOENIX COMPANY, Phoenix, Arizona.**

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## Patrolling the seas— a regiment of sentries, armed and fuzed by Avco!

A fleet of nuclear submarines cruising across the bottom of the ocean is keeping a watchful eye on Peace. Each submarine carries sixteen Polaris missiles—powerful sentries—whose arming and fuzing systems were designed and manufactured by Avco.

Avco's Ordnance Division works in a team with the Naval Ordnance Laboratory to develop the detonation equipment for these first ballistic missiles. Their joint efforts were proved on May 16, 1960, when the United States successfully test-fired a "live" Polaris.

Avco received the U.S. Navy's coveted Certificate of Merit for its work on Polaris. Avco is proud to have a part in the important defense program as well as other missile programs to which it is contributing some of its arming and fuzing know-how.

For more information about Avco's capabilities in arming and fuzing and related ordnance fields, write: Director of Marketing, Ordnance Division, Avco Corporation, Richmond, Ind.

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A DIVISION OF



**We are heavily involved in exotic instrumentation.**



**A case in point is life support.**

In our work to sustain human life in earth orbit, deep space and other hostile environments, we must draw upon the best capabilities to conceive, design and produce a unique array of life support systems and instrumentation.

The knowledge and experience we have accumulated in the fabrication of breathing oxygen pressure control and supply equipment over the past 30-odd years has led, in turn, to these current developments: supercritical cryogenic breathing supply systems; gaseous control equipment; temperature and humidity control devices;

toxic gas removal units and steam turbine air blowers. Systems designed and manufactured by us are in aerospace flight use as well as in toxic, radioactive, underwater and other hostile environments that utilize many combinations of our design, development and production abilities.

In addition to life support, we are involved in cryogenics, propellant measurement and control, precision special-purpose electronics. We would be pleased to help you solve your particular instrumentation problems; just write us at Dept. AFH in Des Moines, Iowa.

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**No one has ever combined high resolution  
and long wear in a telemetry tape...**



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## Army XV-5A\* provides maximum range/payload

Scheduled to fly in mid 1963, the Army XV-5A\* lift fan research aircraft will provide greater payload/range capability than any other high performance V/STOL system.

Now being designed and built by Ryan Aeronautical Company, under contract to General Electric, the XV-5A\* aircraft will be powered by two J85 jet engines which drive submerged wing fans for vertical flight. This unique concept provides two to three times more lift, for a given amount of installed engine thrust, than any other high speed V/STOL design.

Result: Greater payload/range capability—less fuel consumption and need for logistic support. Because the lift fan system multiplies engine thrust by 300 percent, for vertical flight, XV-5A\* engines can be sized for most efficient hovering and cruise conditions and do not have to be oversized to meet V/STOL flight requirements. These inherent and designed advantages give the XV-5A\* performance which meets anticipated requirements for military missions.

—FORNSEEKER NEWS

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

**RYAN**  
AEROSPACE

RYAN'S SPECTRUM OF CAPABILITIES



Conventional XV-5A\* cockpit permits pilots to fly through turbulence without moving hand or foot control positions.



Low velocity and low temperatures of lift fan efflux provide major advantages for operations from unprepared sites.

Volume 76  
Number 5

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### EDITORIAL

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COVER: All elements of Army-Martin Pendragon module were utilized by helicopter during preliminary tests to confirm, the air where the module was suspended. Flight was taken during preliminary tests. Investigation was part of recently conducted operations space capability test performed by Army-Martin Pendragon. Fire control area is shown in large photograph at left; power supply is adjacent to it. (Star photo and details see p. 44, 45.)

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## EDITORIAL

### McNamara on Research and Development

(Defense Secretary Robert S. McNamara last week responded to Congress (see page 10) on matters research and development management in considerable detail (see p. 27). Although we do not necessarily agree with all of what he said we are presenting significant excerpts from this testimony here because of its importance to the aerospace industry—BDA.)

"During the last year or so, we have made a number of important management improvements in the R&D area. I believe it is apparent from my previous discussions of some of the technical developments which we have concentrated in recent years that some better scientific ways in the manner in which the R&D program is managed are being sought. Research and development expenditures, whether measured in budget terms or in program terms, have been mounting steadily over the years, but too much of this effort is not producing useful results. What we want are resources and equipment that the fighting arm can use. We are not interested in supporting the intellectual challenge, but in solving technical, engineering, and design problems. If we are to make optimum use of our available scientific and engineering resources, we must plan our program carefully and concentrate these resources where they will make the greatest contribution to our military posture.

Poor planning, unrealistic schedules, unnecessary design changes and numerous cost increases over original estimates have continuously disrupted the efficient operation of our research and development program. Most of these difficulties have resulted from inadequate program planning and unexamined haste in undertaking large-scale development, and even production, before we have clearly determined that a suitable technological base has been developed on which to build the system. We have often paid too little attention to how a proposed weapon system would be used and what it would cost and, finally, whether the contribution the development could make to our forces would be worth the cost.

Accordingly, we are now following the practice of suspending large system development projects only after the completion of what we call a "program definition" phase. To the greatest extent possible, we want to do our thinking and planning before we start "building metal." Pen and paper and even the feasibility testing of "proof" components, are a lot cheaper than the termination of programs. By a more thorough and complete study and assessment of the facts of each new development—prior to major commitment—we can reduce the number of expensive projects which might otherwise later have to be abandoned, stretched out or terminated.

"I want to emphasize that I am talking about a general rule—about developments which, if successful, would add only marginally to our combat strength. There have been and are exceptions—developments which are sold a new and unique dimension to our capabilities, like the A-1 and B-1 bomb developments and the ICBM. When the potential is off in a technical, quantitative, or qualitative sense, the rule is justified. But developments which meet this test are rare. The typical development program, if successful, to achieve a capability that can also be achieved in other ways, usually including the more extensive or imaginative use of existing weapons. In such cases, the question is not so great. We believe that the substantial increase in the Defense program initiated during the last two years has

put us in a position where we can now afford to move more carefully in the initiation of new major weapon system developments.

"We have also made considerable progress during the last year in improving the operations of our 'in-house' R&D capabilities. Many specific corrective actions and innovations have been made to improve the operations of our laboratories. Special elements of funds are now being made to our major laboratories to stimulate and encourage creative results. Personnel policies are being liberalized to eliminate red tape on small portions of these laboratories for research purposes. The secret civilian pay reform act is expected to be of assistance in holding highly competent engineers and scientists. All of these measures will contribute greatly to the morale of the scientific work force.

"Another major improvement which has been introduced into the research and development area is the organization of the program structure and a simplification of its relationship to the research, development, testing and evaluation budget structure. There are four principal RDT&E appropriations, one each for the Army, Navy, Air Force, and one for the Defense Agencies. These appropriations have been broken down into a total of about 120 sub-activities which are identified in both the budget structure and the program structure. These 120 sub-activities are an aggregation of some 1,600 technical projects which, in turn, are aggregations of something on the order of 15,000 technical tasks from which stem the tens of thousands of individual contracts and job orders financed each year by the RDT&E appropriations.

"Most of the 120 odd RDT&E sub-activities fall under the Research and Development program and constitute its program elements—for example, Nike Sam, Typhoon, B-50 and planned weapons research. However, about 70 of these RDT&E budget subactivities, which we call "operational system development," enter into and become parts of the program elements in other major programs. For example RDT&E sub-activity, "Polaris submarine" is part of the program element "Polaris System" which is included in the Strategic Maritime Forces.

"The approximately 70 RDT&E sub-activities in the Research and Development program have been grouped into five categories: Research, Exploration Developments, Advanced Development, Engineering Developments, and Management and Support.

"It is from the first three categories that we acquire the 'technical building blocks' that we need for our weapons developments. We cannot do the sophisticated engineering job (4th category) unless these building blocks are available. If we fail to provide them in a timely manner, our efforts to define and manage our large-scale system developments more efficiently will suffer and we will waste crash programs and telescoped development production programs which we wish to avoid.

"We realize, of course, that it is impossible to 'plan' technological or defense programs with an exacting accuracy which have not been anticipated. But by planning the 'non-unique' part of our defense research and engineering effort in the large without tying it to a particular system development, we should be able to effect more degree of standardization which, through repeated use of the same components, should increase reliability and reduce costs."

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## WHO'S WHERE

### In the Front Office

William J. McNeil, president of Gerni Inc. Inc. and formerly Assistant Secretary of Defense, elected a director of Fairchild Security Corp., Hightstown, N.J.

Donald J. Stimpert, president and a director of United Fiberglass Inc., Pasadena, Calif., succeeding E. G. Holliday who moved last September to a directorship with H. B. Shaw, president, Talcott Industries Corp., Van Nuys, Calif., succeeding Blaine Tackett, also based in Pasadena.

Jack Rose, vice president, McMillan Systems Development Inc., San Francisco, Calif., also B. C. Davis, director of special planning and a director, Ward Film, electronic engineering, Davis System, electronic systems and in Keith, Pittsburgh, technician.

Kristen D. Davis, board chairman and chief executive officer, American Radio, New York, N.Y., and John S. Hinch, vice president and chief marketing officer, Vi Data, succeeds William B. Glass, Jr., also board chairman.

Dr. Karl Polster, president of Stanford Research Institute, Menlo Park, Calif., succeeding E. Fritz Carter, who became senior management consultant and continues as a director of SRI.

Carl Dorchak, executive vice president of Danforth Corp., Electronic Components Division, Reading, Calif.

George B. Fiske, a director, Administrator of Co. Inc., Wilkes-Barre, Pa. Fiske, a vice president and director of Ford Motor Co.

Dr. Ralph A. Glickman, a director of Chaco Health Co., Success, N.Y. Dr. Glickman is dean of the College of Engineering, Syracuse University.

Albert B. Wright, vice president, general manager, LIT Electronics, a division of Libraton, Inc., Electronics, Bala Cynwyd, Pa.

Philip H. Friedman, vice president manufacturing, Delta Victor Co., a division of Avco Inc., Bloomington, Calif.

Alvin A. Hensley, vice president industrial relations, General Dynamics Corp., New York, N.Y.

Dr. Gilbert W. King, vice president and director of research, InCo Corp., Lexington, Mass.

Robert G. Vaughan, vice president for Lowell, Lindsey, Dr. of General Products, Information Systems Group, Glen Dale, Calif.

E. Frank Glickman, vice president general manager, American Electronic Inc., Telford, Pa.

Irving B. Baker, a consultant to the American Electronic Inc., an expert and test, Cal Jack T. Baker (USAF) will succeed Mr. Baker as a director of AKA's Pacific Division.

Russ Allen, H. S. Mackinnon, Board Vice Chairman, Board Chairman, appointed chief sales executive for Gerni Systems and Russ Allen, F. Sherrill, assigned as the new project officer to Ministry of Science, Victoria, British Columbia.

David L. Hayes, general manager, engineering, B. T. Goodrich Aerospace, and Thomas P. Foster, chief sales officer, B. T. Goodrich, succeeding Frank R. Carroll (Continued on page 184)

## INDUSTRY OBSERVER

►Titan 3A is the new destination of the combination of the Martin Titan 2 (replaced by the Aerjet transporter). It has a design capability to put approximately 5,000 lbs in orbit. Complete configuration with two United Technology Corp. 12B is also available. Configuration is known as Titan 3C. No specific configuration has been identified for Titan 3B.

►Presenting hypersonic test vehicles for Aero's on defense programs (Aerjet), which could be applicable to the Spitz program's intercept missile, are scheduled to be designed and produced by Hughes Aircraft Co. Target vehicle will use two stages to reach peak altitude, then pitch over and the first remaining stage on the downward leg to increase velocity speeds to values for KCBM evaluation. Payload will have a radio transmission operating as KCBM results arrive.

►State-of-the-art studies in the use of organic materials for molecular electronics in generation, amplification, sensing, switching and storage are planned for study in an Air Force Research Office. The program, Efforts and methods, materials, electronic, materials and device fabrication. Proposals are due Feb. 11; contracts should be awarded by May 10.

►Loading characteristics of a conventional supersonic transport configuration (a light jet) is being considered by two methods suggested by researchers at the Ames Research Center of the National Aeronautics and Space Administration. One method would add an air horizontal tail to free the jetting elements from large flap deflections as the wing, the other method would require a free-floating control surface about twice the size of that called for by other aerodynamic design considerations.

►High-speed, high-precision rocket motor, which could be developed to operational readiness in 1972, at the object of a rocket being conducted by Lockheed Martin and Space Co. Motors would be needed for new spacecraft.

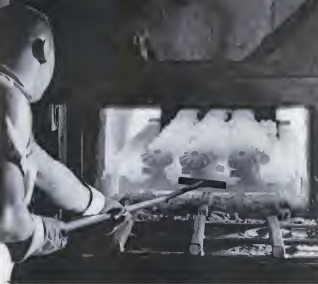
►Aerodynamic interference testing, which can occur in areas where boundary layers and shock waves interact, has become recognized as a major problem in hypersonic vehicle design. This testing can pose difficulties for designers who plan special aircraft geometry to produce favorable pressure fields for improving hypersonic lift/drag ratios. Some tests have shown local heating rates to be twice the unheated values.

►Hatched patrol craft is under development for the Royal Canadian Navy in the Montreal Aerjet of Canada. Ship will be in the 200-ton class and is expected to have a 60-knot cruise speed in a State 3 test.

►Cause of the fire which destroyed the Aero-Viking firing test bed for the Bristol Siddeley Olympus 22-R engine (AW Dec. 10, p. 15) was failure of an engine component. Part was ejected through the tailpipe and impaled into the substrate of the Viking's wing, ripping open a fuel cell which dumped fuel on hot sections. Engine was being developed for the F-35B engine, which is scheduled to be tested for Bristol Siddeley to get a second Viking for engine flight test, become another version of the engine—the Olympus 593—is scheduled to be tested for the Anglo-French supersonic transport.

►Watch for increased interest in the subsonic as an STOL vehicle. Special parts by male interest in the Chalkhug U-15 project and parts by current emphasis on STOL performance, at least four companies—some recently organized—are preparing designs or building this type of aircraft.

►Feasibility study and preliminary design of a transient surface effects simulation will be supported by Air Force's Ballistic Systems Div. Proposals in an industry competition were submitted to BSSE in mid-July. Simulation is intended to test guidance and control algorithms for advanced ballistic missiles, include exchange ballistic missile, and the three current USAF KCBM, in an environment of gamma rays, neutrons and electromagnetic pulses of nuclear detonations.



Barney was not problem for Haynes ceramic shell mold in 1968.

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## Washington Roundup

### U.S. Nuclear Strategy

Growing number of hardened Soviet missile sites and missile-launching submarines will make it increasingly impossible that the U.S. could ever destroy enough of Russia's strategic nuclear forces to produce major damage to the U.S., Defense Secretary Robert S. McNamara told Congress last week.

That means that the nuclear power of the U.S.—although it now could destroy the entire Soviet target system after absorbing a surprise attack—becomes less and less of a deterrent to a first strike by Russia.

The changing character of the Soviet military structure is forcing the U.S. to reconsider again and again on a flexible, non-dogmatic basis that when it comes to "strike options"—ranging from the ability to strike back at Russia's entire target system at one time to a highly selective, step-by-step retaliation that could begin with a strike at all long-range nuclear forces—and then if necessary, strike back at the Soviet urban and industrial complex in a controlled and deliberate way."

### Strike Options Sought

Soviet leaders have always talked as if they would strike "at the entire complex of our military power, including government and production centers, military air bases," McNamara said. "But we have no way of knowing whether this would actually do so. It would certainly be in their interest as well as ours to try to find the terrible consequences of a nuclear exchange. In building into our forces a flexible capability, we at least eliminate the prospect that we could strike back in only one way, namely against the entire target system, including their cities. Such a prospect could give the Soviet Union no incentive to withhold attack against our cities in a first strike. We want to get them a better alternative.

Second strike force is planned to be able to destroy virtually all soft and semi-hard targets and a large number of fully hardened missile sites and still have a "postured force" left to use against urban and industrial areas, McNamara said. But it does not anticipate ever being able to close out all hardened missiles and hidden missile-launching submarines.

### Anti-Sub Capability

"We have not found it feasible, at this time," the defense secretary explained, "to provide a capability for ensuring the destruction of any very large portion of the fleet, first shot, if the Soviets build their in quantities of all missile-launching submarines. Fully hardened ICBM sites can be destroyed but only at great cost in terms of offensive weapons required to dig them out. Furthermore, in a second strike situation we would be attacking, for the most part, targets areas from which the missiles had already been fired."

In spite of the huge sums being spent on anti-missile and anti-submarine warfare research, McNamara said, "it is not very likely that our efforts will produce enough of an edge as to our capabilities during the period under consideration to change the prospects significantly."

Presently, either side will be able to destroy so much of the other's strategic nuclear force that an devastating retaliation blow would be possible, McNamara said. This is a "gross prospect" even if it should result in mutual destruction, he said. "It underscores the need for a second effort to find some way of not to eliminate these deadly weapons completely, but at least to show them in such a way that their accumulation and use would be extremely disadvantageous which would reduce the need for either side to resort to their worldwide use of elements of their intercontinental forces."

### Cuba Reconnaissance

U.S. photoreconnaissance was unable to detect Soviet ballistic missiles in Cuba for almost a month after they began to arrive in the fields of Russian fighters in mid-September, McNamara told Congress last week. First reliable report on the missiles came from a Cuban source, he said. "The missiles were introduced and deployed at night under heavy Soviet air cover. Not until October 14, when the U.S. launched a reconnaissance aircraft overflight (SR-71) missile site in the San Cristobal area was the Oct. 14 U.S. flight led on. It produced "hard photographic evidence" of an MRBM complex, McNamara said. Progress for low-level coverage of the entire island by Navy-Vought F-104's and USAF McDonnell RF-4's was not ordered until Oct. 23. These flights were made at 500 to 1,000 ft altitudes, with flight times over Cuba ranging from 4 to 7 min.

Russia still has 17,000 military personnel in Cuba, organized into four separate combat forces, according to the 24 SAM-2 mid-course missile sites and three SA-2 MR-21 tactical interceptors that are part of the island's air defense system, the defense secretary told Congress. McNamara said there is no evidence that any MRBMs or ICBMs have been sent to Cuba and he is "convinced beyond any reasonable doubt" that 42 MRBMs were shipped back to Russia between Nov. 5 and 47 ICBMs were returned on Dec. 5 and 6.

—Washington Staff



## First Titan 3 Phase 2 Contract Approved

Phase development contract for a major element of the Titan 3 standard space launching system is to be signed and the first phase contract won by the Lockheed-Goddard Technology Corp.

Cost plus incentive fee contract, with a maximum value of \$375 million, covers development, flight test and final proof of the 120-in. solid propellant stage under the Titan 3 booster. Incentive profit under the contract will be split 50-50 between Lockheed and NASA, based on meeting objectives on performance and on reliability goals, successful flight.

At Phase System Command's Space Station Dept. approved and signed the contract, which is also approved by a Defense Dept.-Air Force review committee in Washington.

Three earlier stage phases of the program were completed last spring, but extensive review and negotiation has delayed the signing of Phase 2 contract, which covers development of the system (AWM May 21, p. 30).

Status of the other contracts:

- **Marine Drifter.** Contract for the Titan 3 double propelled test was signed by Space Station Dept. and forwarded to Washington. General parameters for contract were given, but no approval has been given yet back to the Lockheed Co. for further negotiations under these parameters before final release. First price was about 60% of total estimate.
- **Avant Guard.** Contract with Boeing Bros. (Boeing) for the two-stage test was approved and was being forwarded to Washington last week. Contract with Aerojet Electronics for the test support is being negotiated.
- **USAF Flight.** Contract contract is signed.

3-111 separately, will replace Navy and Marine Corps F-4Bs. Marines will get one B1-4B reconnaissance version of the 4B, with only 1968 funds. • **Decision.** A-4B. McNamara said the aircraft is only slightly better than the Douglas A-4C and therefore, it does not seem wise to make any two-stage conversions to that aircraft design. The first two-stage conversion will be to the A-4C (the A-4C is the version, comes out longer than we had originally planned and through source, the attack is quite superior to that of the A-4C). The A-4C is the version, comes out longer than we had originally planned and through source, the attack is quite superior to that of the A-4C. The A-4C is the version, comes out longer than we had originally planned and through source, the attack is quite superior to that of the A-4C.

• **North American A-4C.** McNamara and Dikens. They had planned to buy 1,000 A-4Cs in 1967 through Fiscal 1967. But "we were in the attack version of the A-4C (the A-4C) is being redesigned to be a more advanced version of the A-4C by about the same time."

• **Generalized S-1E.** McNamara said the Defense Dept. no longer plans to supply these aircraft to Naval Reserve Squadrons but will use them only in the inventory. The Defense Secretary did not speak from being in the field, but the members present at the meeting had been told.

• **Shuttle S-1E.** This is the "preliminary study of a shuttle vehicle." McNamara said, "Defense in Fiscal 1968 plan to buy 100 shuttles of S-1E and to run the vehicle in the present form in 1968." But the Fiscal 1968 plan is to buy 100 shuttles of S-1E and to run the vehicle in the present form in 1968.

• **Lockheed F-104.** McNamara said the Air Force is planning to buy 1,000 F-104s in 1968. The Air Force is planning to buy 1,000 F-104s in 1968.

• **Other aircraft.** McNamara said he is considering the purchase of 100 F-104s in 1968. The Air Force is planning to buy 1,000 F-104s in 1968.

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delayed in Fiscal 1968. First five subs were equipped with the Lockheed A-1 surface-to-surface missile, which is a cost of 1,200 each. The first five subs were equipped with the A-1 surface-to-surface missile, which is a cost of 1,200 each.

McNamara and the 40 who will be required to support that of the tradition, we supply ships and a number of former destroyers and other support ships. Through Fiscal 1968, Defense Dept. received orders for four destroyers and three supply ships and is asking for more in Fiscal 1969 for a 50th tender and fourth supply ship. It also wants about 51 destroyers in Fiscal 1969 to complete the 1968 missile support fleet at Bangor, Wash. A new contract for 100 Polina subs is being ordered by the Defense Dept. and a new contract for 100 Polina subs is being ordered by the Defense Dept.

• **Vought Republic.** McNamara said the Vought Republic is a new version of the A-4C by about the same time.

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## F-104Gs Undergo Major Modifications

General—Approximately 200 Lockheed F-104G aircraft, including those delivered from the U.S. and the United Kingdom, are being modified through a major modification program in an effort to boost performance and reliability.

Modifications, ranging from 10 to 80 in number depending upon the aircraft, suggest problems in the production line and the fact that the aircraft are being modified to meet the latest requirements.

Modifications include addition of 100 bolts on one of the air-to-air missiles, a strengthening of structural components in the wing and tail section and installation of an additional structural joint in the cockpit.

Under a continuing program, the Defense Dept. is working to improve the reliability of the F-104G aircraft. The program is being carried out by the Defense Dept. and the Air Force. The program is being carried out by the Defense Dept. and the Air Force.

These further plan organizational problems, also have delayed the planned starting date of Category 5 flights by the Air Force to approximately six months. New date for beginning the tests is now set for April.

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• **Parade C-123.** McNamara said that his plan is to use the C-123 in the future. The C-123 is being used in the future.

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**Nord 262 Pressurized Transport in Flight Test**

Nord 262 transport pressurized derivative of the earlier 260 Superherald aircraft in ongoing flight test. Aircraft, which made its first flight recently, retains much the wing of the 260. Conventional conventional pressurization, fuselage and cabin layout design. Note that no tail finning has yet been added. Nord 262 carries 26 passengers and is powered by two turbofans (Boeing 6) developing output of 1,000 hp each, with water-methanol injection system added.

low flight research schedule under Navy management, with two prototypes planned, X-19, a Canard-Wright Model 330 aircraft with two YF-15 engines and from lifting capabilities. Air Force will provide two YF-15 for flight studies.

In fiscal 1984, the Army will fund both the X-19 and Air Force one fourth each of the U.S. share of the development cost of the British Hawker P.1127 V/STOL, high velocity vertical launch aircraft. United Kingdom and Germany are sharing in development costs. Air Force also will work in fiscal 1984 on advanced propulsion studies for this aircraft.

**International-nations effort.** Advanced Research Project Agency in Fiscal 1984 will receive \$125 million for Project Defender as well as to determine how best to defend the U.S. from Korean missiles and some U.S. missiles of continuing Soviet delivery. McNamara said a "majority share" of this effort will be a study of needs, weapons philosophy, including ballistic missile intercepts in the Pacific.

Defender will help define the future Nike-X development program. It is now generally agreed, McNamara said, that the Nike-Zen program, which began in 1961, would not be effective against a sophisticated threat in the late 1960s and early 1970s.

It, and a series of the program directed from representatives that could be made in the present Nike-Zen (1) High Zone discrimination radar as a high velocity, lower accuracy, target radar; (2) mid-range radar as a radar intercept an incoming missile at a

lower altitude; (3) developing a new, high accuracy radar (Sperry) which would have accuracy twice to discriminate between real missiles and debris; (4) developing an advanced radar which could contain a large number of targets.

After considering these possibilities, Defense Dept. decided to develop a Nike-X, which incorporates the Sperry missile and advanced radar concepts McNamara said. An advanced Nike-Zen to protect the U.S. territory that would be an improved missile, defense, he said, still has not been practical because "we still have a great deal to learn about recent phenomena and techniques for discriminating between real and false targets." The Nike-Zen U.S. defense system would be affected by another explosion of intercepting missiles.

"It is imperative at this time, in current analyses to this protection of our territory and continue to be a time studies with advanced, limited capabilities," McNamara said. He said over \$400 million, as in fiscal 1984 budget for Nike-X, Nike-Zen and related Project Defender work, but the anti-missile program also in direct study of how to conduct air missile launched missiles.

**Assurance phase.** McNamara said Defense Dept. plan to study the basic problems first, particularly the development of the necessary components, he said we should continue to begin the new program, modern development phase. He said, "continued emphasis in fiscal 1984 will be placed on developing the initial program for the effort."

## K Lockheed-IAM Pact Omits Union Shop

Los Angeles—Lockheed last week of the Lockheed Aircraft Corp. International Union of Machinery workers has strongly disavowed membership of the pressurized airplane board-approved pact. The pact, which is an extension of the company's new as a union shop, which had indicated negotiations (AW Jan. 25 p. 32).

Employees of the contract for the IAM was generally considered a setback for the union. This setback, without the union shop, may set a pattern for future setbacks, such as the Boeing IAM dispute, which is now subject to the 30-day Taft-Hartley cooling-off period.

Since receiving passage passed by Lockheed and accepted by the IAM.

However, contract, as direct work Feb. 23, 1983, and scheduled in June 23, 1983.

**Increased wage negotiation.** pending for members of the 14,000 per hour for two years beginning last July 21 and ending on June 21, 1983, the following annual period, with a 6 to 9 percent limit in the third year of the contract.

Vacation benefits also were increased from a present maximum of three weeks in four weeks after 25 years of service. Workers will receive a three-week vacation after 10 years of service to 12 years under the old contract.

**Lowest benefits.** according to approximately 75 cents per hour, with another 75 cents per hour, providing \$75 for each year of employment.

## Military Comsat Bidders' Briefing Set

Antennae and ground equipment planning to bid on the Air Force contract, which will be the communication satellite program, designated MFC (AW Dec. 24 p. 13), will be briefed Feb. 6, USFV Systems Comsat System Study. Air Force officials will award two or three parallel mobile studies for a program of defense, on the basis of proposals submitted to be submitted to the MFC. The contract, planning to prepare proposals for the program as of late last week included John Deere Corp. of America, Space Technology Laboratories, General Dynamics/Avionics with Hughes Aircraft Co., General Electric with Motorola, and Lockheed Martin and Space Co. with Telecommunications, about 10 companies were invited to bid.

Self-Propelled Laboratory was scheduled in a late last week on whether or not to participate in the competition. On the basis of an assumed future contract, the Air Force is expected throughout the studies, as a general contractor, should be able to bid the USAF communication satellite program.

An Air Force reportedly scheduled in a 1983-84 on-site, automatic communication satellite system, which would involve at least 20 satellites in medium orbits at the same time.

As many as five to seven satellites would be placed in orbit by a single Atlas Agena D booster combination. The number of orbit vehicles may be limited to about five. Exact satellite weight will be determined in the course of the studies.

Communications capacity may be indicated in use for three channels in the satellite program.

For special programs, with 61 antennas, including Korea.

Satellite space highlights were shown.

**• Titan 3** was approved for development in late August. It is expected to arrive in a general purpose launch vehicle for both Defense, Dept. and National Laboratories, and Space Administration. In a dramatic, in addition development program on standardized Titan and Atlas vehicle production.

**• S-28 (Dynaflow)** configurations for work done, and structures of the first flight will begin this year.

**• Satellite systems** approved in the fall of the 1983-84, in aspects based on NASA's General Electric Mission as a contract to build ANNA guidance satellite which records will be provided to NASA production, and the nuclear detector satellite, which is measured in the Defense Dept. will be developed in the Defense Dept. at the Western Electric Communications section.

## Kennedy Report Reveals USAF Launched 33 Satellites in 1962

Washington—Air Force successfully launched 33 satellites and three probes during 1962 using the new Titan Agena D vehicle at least five times according to President Kennedy's report to Congress on activities and facts activities during last year.

The statement is the first comprehensive list of military space launches since the Defense Dept. decided to withhold information on its launches last year (AW Aug. 10, p. 35).

Although United Nations maintains a system of objects launched into space, the list is brought up to date, only information.

The President's report says the U.S. successfully launched 33 satellites and three probes last year and failed at 11 satellite launches and two probes attempt. The report contained a statement by Vice President Lyndon B. Johnson, chairman of the Space Council, that the U.S. space program is progressing at a faster rate than that of Soviet Russia and that Russia is experiencing its own difficulties with the U.S.

Russia launched 15 Cosmos satellites, two manned Vostok and a Mars probe, last year.

The report implied that USSR had at least three unmanned failures during last year.

Analysis of USAF launches last year indicates strongly that at least five operational space or military defense communications, which may be in the air and because in the operational communication

they are launched in Atlas Agena Ds, and are, according to the Air Force, also launched.

U.S. launches the need to report details information to the UN on its Atlas Agena D satellites, launches in Augusting these after they have been received. In this way, the report, price and period for the included in this report. Launches with this report, the launch of the 33 satellites, Aug. 7 and Nov. 11 last year. Directors of all new, described as development of space flight techniques and technology, in space sciences and exploration.

In the report, both Defense, Dept. and Air Force, Congress was told to be making progress on the satellite defense system, called Vela (AW Sept. 23, 1963) p. 35) consists of two identical satellites.

The report also said that progress in the Gemini and Ranger programs and space with the (statistical) that in 1962 the United States achieved a new footing on the frontier of space, because of both the number and complexity of its accomplishments.

Space systems, space, communications, and communications, which may be in the air and because in the operational communication

## Approval of Comsat Incorporations Sought

Washington—Antenna for incorporation of the Communications Satellite Corp. was to be filed with the Dept. of Commerce government last week, and President Kennedy said the Senate to confirm 12 permits is expected in its conference last fall (AW Dec. 15 p. 37).

President Kennedy did not name a replacement for Philip L. Graham who resigned as chairman of the incorporation.

Graham, who is president of the Washington Post Co. and chairman of the board of the corporation, was in his ongoing business the incorporation, which was agreed to direct two months complete and launch of new launch.

Incorporation will require within the next week, or so, as a temporary board of directors. The incorporation will require a chairman, president and technical advisor in the group.

Under the terms of the stock, a permanent board of directors is to be organized.

Then, members will be appointed by the President, as is the permanent chairman, president and technical advisor.

Price of the stock is not to exceed \$300 per share.

Individual purchases will be limited to acquisition of no more than 10% of the voting stock, and communications carrier will be limited to no more than 10% of the shares owned by the corporation.

Sale of stock in Communications Satellite Corp. is not expected to take place in a year or more.







rated pilot is also a contract worker from Australia performing the training of F-16s. OGA, using its own aircraft beginning July 1, a fourth time significantly, is increasing effort will be made. These will also be contractors. The aim of the course is to have every initial pilot with an aircraft while flying. This stage follows those provided in the Federal Aviation Agency and the military services.

#### Army's Goal

However, is the Army's primary responsibility in its flight training program. Brig. Gen. Robert R. Williams, commander of U.S. Army Aviation Center, Ft. Rucker, told a meeting of the National Aeronautics Services Association last week, "The Army's primary role is to provide the initial training and aircraft maintenance."

Since the Army's training requirements have increased, Williams said, contractors have been used to help in obtaining the need for the Army to assess the costs of operating additional bases.

The Army is also looking into the possibility of using off-the-shelf, new engine equipment for increased training of helicopter and fixed-wing pilots. There have been reports in the Fiscal 1984 budget. If the funds granted are successful, the number of aircraft needed, a large amount of work will be used for the duration of the transition program.

Another reason for wanting off-the-shelf aircraft, he said, is to maintain a pool of training aircraft. "It is not needed for operational needs whenever a military emergency arises. This has happened in the past, he said. Maintenance supply problems would be handled with off-the-shelf aircraft from Williams said. Commercial sources in many parts of the country could be used, bypassing the need for an Army reserve of spare parts.

Army is concentrating on using foreign aircraft by transition and advanced training because in the near future,

the Army will have no access to helicopter aircraft. The operational training aircraft will be the de-facto, C-130, C-141, C-145, C-147, C-148, C-149, C-150, C-151, C-152, C-153, C-154, C-155, C-156, C-157, C-158, C-159, C-160, C-161, C-162, C-163, C-164, C-165, C-166, C-167, C-168, C-169, C-170, C-171, C-172, C-173, C-174, C-175, C-176, C-177, C-178, C-179, C-180, C-181, C-182, C-183, C-184, C-185, C-186, C-187, C-188, C-189, C-190, C-191, C-192, C-193, C-194, C-195, C-196, C-197, C-198, C-199, C-200, C-201, C-202, C-203, C-204, C-205, C-206, C-207, C-208, C-209, C-210, C-211, C-212, C-213, C-214, C-215, C-216, C-217, C-218, C-219, C-220, C-221, C-222, C-223, C-224, C-225, C-226, C-227, C-228, C-229, C-230, C-231, C-232, C-233, C-234, C-235, C-236, C-237, C-238, C-239, C-240, C-241, C-242, C-243, C-244, C-245, C-246, C-247, C-248, C-249, C-250, C-251, C-252, C-253, C-254, C-255, C-256, C-257, C-258, C-259, C-260, C-261, C-262, C-263, C-264, C-265, C-266, C-267, C-268, C-269, C-270, C-271, C-272, C-273, C-274, C-275, C-276, C-277, C-278, 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FOKKER F-27 aircraft are being used as lateral assets such as in Deromdham, Tanganyika in Nairobi. Present fleet of three may be expanded as DC-3 placement program. Airline presently operates nine DC-3s.

## Independence of Four Territories May

By Robert H. Cook



EAA TECHNICIANS remove a Rolls-Royce Area powerplant from one of the airline's three Comet 4s of the company's scheduled and unscheduled fleet at Nairobi Airport. Under present system of progressive maintenance each of these Comets flies 16 days, spends five days of the third week in a block check.

Nairobi, Kenya—East African Airways is entering a period of reevaluation and consolidation in preparation for political and economic problems that may arise from the independence of its four territorial assets—Kenya, Tanganyika, Uganda and Zanzibar.

As one of East Africa's most profitable businesses, EAA is aware that it may find itself caught in an international war between the countries, as the subject of heavy new taxation is all but lost. In any event, it is prepared for a demand that African be given more employment and responsibility in the company.

Kenya, as the most heavily populated and developed of the territories, holds the key to EAA's future. Though low-mach influence, Kenya's political interests may event as the United States be refused fully until after the territory becomes independent in the near future.

Tanganyika and Uganda are under protest and Zanzibar also will be requested by the British very soon. African leaders continue the colonial territories of an East African Federation that would include these territories and Northern Rhodesia and Northern.

But it may be some years before such a federation can be achieved, if ever.

There are two strong political groups



EAA COMET 4s en route from Johannesburg, South Africa to London, make stop at Nairobi. Fleet of three Comets is used on predominantly north-south routes plus service to India. Three-armed time as Comets has been reduced to less than 45 min.

## Give East African Airways New Problems

has in Kenya now, both bidding for control of the country, while a third faction wants a full separation of North Kenya split from the independent territory.

Uganda, in turn, is an independent British protectorate but conducts its affairs under the strong influence of controlling tribes who do not always agree with the Kenyan leaders. Zanzibar has prospered under a British-appointed sultan but may, and might be expected to prefer a continued alliance with the British. Tanganyika, probably, would favor a federation if it is not dominated by Kenya politics.

One of the few areas of mutual agreement between the territories is their backing of the "United Independent States" a freely strong affecting airlines in some African nations (AWI Jan. 14, p. 41; Jan. 21, p. 45; Jan. 28, p. 42). Indicators of this support is the fact that one of Kenya's first independent actions was the re-naming of famed Mt. Kilimanjaro as "Uhuru Peak."

Rapid pace of the British government's withdrawal from Kenya is the driving concern of EAA. With eight companies, most of profit, the airline has been going to a continued growth. It now finds itself tied to a decreasing schedule of aircraft payments for three Comet 4s and three Fokker F-27s at a time when political unrest in Kenya is shifting its best sources of revenue—



NAIROBI AIRPORT, at Nairobi, is hub of several EAA operations served by Fokker F-27s and Douglas DC-3s. Airport is surrounded by Royal Nairobi Game Park.

annual travel to Europe by British civil servants and white settlers.

Nearly 70% of EAA's annual income is earned by the international Comet flights. The airline could be placed in a precarious financial position as its decrease in this traffic. Its net profit for 1960 was \$779,000, and while international traffic was high last year, EAA forecasts a decline discussed first

following Kenya's independence.

There is also the concern that EAA may eventually suffer at the hands of its American licensee British Overseas Airways Corp. Once that gain independence, the East African territories are not likely to have sufficient business to afford purchase of more equipment by EAA. BOAC, EAA, Comair, African Airways and South African Airways







## NEW YORK TO LONDON IN 3 HOURS

# BRISTOL SIDDELEY AND SNECMA

## SUPPLY THE POWER

Supersonic engines are being jointly developed by the British and French aircraft industries which will carry 100 passengers at more than twice the speed of sound. These aircraft will be powered by four Olympus 593 turbofans, which will produce a total of more

than 50 tons of thrust. Development and manufacture of this engine will be undertaken jointly by Bristol Siddeley Engines Limited, and the Société Nationale d'Etude et de Construction de Moteurs d'Aviation.



### Wings Mated on First BAC 111 Fuselage

Wings have been mated to first British Aircraft Corp. BAC 111 twin-jet transport at Haw plant of Vulcan-Aeromarine. First structural test fuselage, including its stands, is being built at Bristol Aircraft Works. First BAC 111 for British United Airways is in jig.

## Hughes' Silence Is Major Issue in Merger

New York-based Hughes' non-consolidated partners are developing into a major aviation unit, as the proposed merger of Pan American World Airways and Trans World Airlines (AW Jan 2, p. 18).

Civil Aeronautics Board's report that the merger proposal is a stockholder vote before the Board begins action on the application is an indication of the strategic question posed by Hughes' decision not to declare himself.

CAB reportedly does not want to become a partisan arbitrator in the race conducted around Hughes' 75.75% ownership of TWA. Should the Board rule in favor of the merger, TWA would gain a strong "public interest" position in voting Hughes' stock for the merger.

Vote of 2:1 for the merger is virtually assured from the three-man trusteeship controlling Hughes' stock. As matters now stand, neither side in the race has a negative vote could be expected from Raymond M. Haffner, a vice president of Hughes Tool Co. and Hughes' single representative on the trusteeship.

In the agreement in which Hughes surrendered voting control of his stock in exchange for a \$105 million loan, it is specified that the trustees not vote the interest as a merger.

But legal sources emphasize that while the trustees have the mechanical power to exercise this right, a question remains as to whether it has the effective power to vote the stock in this particular merger. Hughes could still play

legally that his interest is being donated.

"You can't expect a man to give up a supermarket in exchange for a neighborhood grocery store," one legal authority said.

TWA naturally would like at least an "advance opinion" from the CAB, which could come through an executive's memorandum, as defense against possible pressure from Hughes following a stockholder vote. The trustees who could expect to be singled as a most vocal also feel more confident in expressing their vote if they feel the government's opinion is behind them.

TWA and Pan American, in their original merger application, suggested a stockholder vote within 90 days after the merger is approved by the government.

Following the report by CAB's Bureau of Economic Regulation that the stockholders express themselves prior to an Board action, the carriers suggested a vote fall due after public hearings on the merger. An executive's recommendation would provide the public hearings.

TWA and Pan American and their stockholders would be in a better position to act due to Hughes' limitations with the merger plan as it would be outlined in the public hearings. The two carriers filed suitcases wherein a Board trust had been taken before a stockholder vote, namely the Delta Air Lines merger with Chicago & Southern Air Lines and Eastern Air Lines merger with Colonial Airlines. But the CAB also can recall the time and effort lost

in approving the now-cancelled merger of Northwest Airlines and Capital Air Lines, which Northwest stockholders rejected after the Board's approval.

Hughes' sentiments about the merger could emerge during his personal appearance for deposition taking in the litigation between himself and TWA. He is currently scheduled to appear Feb. 11 in Los Angeles.

Hughes' attorneys in New York, Cleaver Davis, has taken steps that could forestall the appearance. Acting on a recent Supreme Court decision (AW Jan 21, p. 42), Davis is seeking to have the hearings transferred from the courts to the jurisdiction of the CAB.

The Supreme Court ruled that the CAB must handle legal problems arising between Pan American World Airways and Pan American Grey Air Lines (AW Jan 21, p. 42). Hughes' counsel will attempt to show that the Hughes-TWA dispute should be treated as a similar matter.

Davis planned to file the request of some last Friday, in conference with the date proceeded in July. Charles Newman of the Southern District Court of New York, however, is probably content that Davis would ask for some time.

Filing of the motion in regard to jurisdiction could stall the scheduled Feb. 11 appearance of Hughes, more it is himself, prevented to the court. Hughes' counsel said the court must rule on the new motion before the related legal procedures can continue.



# Are "next generation" flight



Honeywell self-adaptive flight control systems have been flying nearly four years in the F-101A (left) and X-15

(center) vehicles. A proven triple-redundant version is now being provided for the orbital X-20A space glider.

## Here are the benefits of Honeywell's pioneering in adaptive systems

**LOW DEVELOPMENT RISK**—Next generation aircraft price reductions can plan for minimum development time and firm delivery schedules with the Honeywell adaptive system.

**PROVEN PERFORMANCE**—The Honeywell system can handle the most advanced configurations under drastically changing flight conditions in all three axes; actual flight demonstration prove this.

**RELIABILITY**—Predicted operational reliability for current Honeywell systems exceeds 100,000 hours on/air. Honeywell systems have consistently met or exceeded their predicted reliability.

**FAIL SAFETY**—Honeywell systems are designed to be inherently fail-safe. This is a result of years of

pretesting, fail safety analyses on every Honeywell flight control circuit and component.

**ADVANCED DESIGN**—Circuit design and packaging produced by Honeywell for current manned aerospace programs (Olympic Apollo) meet all requirements for next generation aircraft.

**MAINTAINABILITY**—This is a primary design parameter on Honeywell products. Maintainability design is based on lessons learned in over 1.2 million system operating hours of actual flight experience.

**GROWTH POTENTIAL**—Accommodation of other key functions such as automatic terrain following, automatic attack, etc., is an inherent feature of the Honeywell adaptive AFCS design.

## Honeywell system carries three unique guarantees

Such has been the performance of Honeywell's triple-redundant adaptive AFCS that the company is willing to guarantee, subject to penalty payments, that the system will:

- Satisfy in-flight performance requirements within a specified maximum period of flight test.
- Equal or exceed specified minimum inherent reliability requirements.
- Require only a stated minimum of corrective maintenance down time.

# control systems already flying?

## Honeywell self-adaptive systems offer guaranteed flight-proven control of high-performance aircraft

Automatic flight control is one of the primary problems in designing the much discussed next generation aircraft. New airplane designs have reached the point where self-adaptive damping and control is essential for safe flight in all regimes—and for mission success.

Eight years of work at Honeywell (and 200,000 man hours of design engineering) have already been spent to solve the problem. This effort has produced a self-adaptive flight control system so effective,

reliable, and easy to maintain that Honeywell will guarantee its performance in all three of these areas:

### 360 Actual Flight Hours

Honeywell's system, the first 3 axis adaptive AFCS, first flew in a supersonic F-101A in May 1959. Since then, increasingly sophisticated versions of the system have accumulated 360 hours of flight time in over 220 flights, including fourteen X-15 missions.

Complete triple-redundant adaptive circuitry has been developed and test-

proved by Honeywell for the X-20A Dyna Soar program under subcontract to Boeing, the prime contractor. Production packaging will meet the most rigid aerospace requirements for weight, size and operating environment. Operational reliability predictions for this system exceed 75,000 hours mean time between failure.

Honeywell has developed and produced more than 45,000 automatic flight control systems—more than any other supplier. Current military versions are flying the Air Force F-300, F-101, and B-66; the Navy W-2 and S-2F-3, and the worldwide F-504.

For more information on Honeywell's Adaptive Flight Control capabilities, write: Honeywell, Dept. 671R, 26500 Ridgway Road, Minneapolis, Minnesota.

## Eight years... and millions of dollars

The government has invested nearly \$9 million in developing the Honeywell Adaptive AFCS to its present state of readiness. These government-funded programs include:

- Procuring Agency** Program
- USAF—A-10** X-15 3-axis redundant self-adaptive flight control system and automatic bleed-off equipment
- USAF—A-10** Elastic Space Booster flight control study
- USAF—A-10** Elastic Booster Adaptive Flight Control System development and evaluation
- NASA** Saturn Booster Flight Control Studies
- Boeing (DARPA)** X-20A Dyna Soar Triple Redundant Adaptive Flight Control System

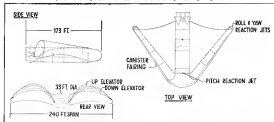
In addition, Honeywell has funded (1) the initial adaptive AFCS component and system development; (2) the early portion of the adaptive system flight test and demonstration in the F-101 and the F-101; and (3) preliminary elastic booster studies.



# Honeywell

ENGINEERS AND SCIENTISTS—Explore new professional opportunities. We'll find it. Write: Honeywell, Minneapolis 5, Minnesota.





**BUILT-IN PARADOX** recovery valves, proposed by Space-General Corp. for Saturn first stage boosters, would have simple guidance and control but ground rules would track vehicle to landing site. Elsewhere, shows serious shortcomings.

## Large Reusable Booster Designs Studied

By C. M. Plattner

**Los Angeles**—High costs of post-Apollo lunar and interplanetary missions will require that large, reusable boosters developed for those missions be turned up to 18 times, according to a design feasibility study by Douglas Aircraft Co. for National Aeronautics and Space Administration.

Preliminary conclusions of the study were presented at the annual national American Astronautical Society meeting here in Philip Brown, assistant director of advanced launch vehicle studies at Douglas Missile and Space Systems. Dr. Douglas is conducting one of three experiments of advanced design concepts funded by NASA's General Dynamics Astronautics and Read Corp. on advanced launch studies.

Bono told the meeting that overall utility vehicle operational costs would be 50% less than nonrenewable vehicle costs. Projected operational costs for manned planetary exploration missions by Mars—exclusive of research and development costs—are expected to be about \$1 billion per year for a 10-year period starting in the early 1970s. Lunar base support missions of similar cost—only with planetary exploration missions, would cost an additional \$1 billion each year for the first five years.

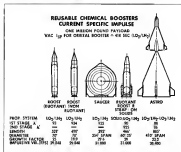
NASA's tentative goal of \$25/Tb of payload placed in orbit could be achieved with a reusable disc-based booster, Ross said. The \$25/Tb figure, which includes operational as well as research and development costs, is comparable to the cost of launching

substantially less than the requested \$1,000 and \$270/ha of postpaid interest for the respective type C-4 and C-5 houses, respectively.

*Pontoporeia* larvae generally is referred to as Nereis. Other proposed names include Cirratulid Larvae, Annelusculidae, Polychaeta, and Eteimachus.

Lamach Interplanetary Orbits Spacecraft and Douglas Aircraft Co. a Rocket (Reusable One-stage Orbital Space Truck) Nova study contracts let by NASA are for a follow-on C-5 booster but so are some of the space agency's next Nova study contracts.

Post-Saturn C. 3 lunch schedule. Break



**NON-INDUANT VERSION** of Kinet vehicle is lighter of reasonable chemical barriers under consideration. This version would use inflatable blent body, drug coat the recovery system. Drawers also shows that other reasonable chemical barriers should be thought.

will, should be capable of placing 1 million lb into a 175-cu-yd, circular earth orbit and should become operational by 1972. High cost precludes simultaneous development of two different types of booster-propellant systems, such as nuclear and chemical, which would become operational at the same time, Rosen said.

Chemical, rather than nuclear, engines are suggested, since nuclear engines of sufficient thrust levels are for the upper stages probably will not be available by the projected operational dates. Another consideration is difficulties posed by cladding nuclear engines. Preventing control problems due to ionizing radiation may require engine operation distances of up to 50 ft, with associated decline.

To arrive at design algorithms for the advanced booster, Douglas engineers studied all known vehicle configurations of single- or two-stage-to-orbit capability for a 1-million-lb-payload mission. Both recoverable and nonrecoverable configurations were considered and ranked from a vehicle designed Nov. 3, with a liquid oxygen/liquid hydrogen first stage, to the Titan vehicle, a hybrid chemical/liquid booster.

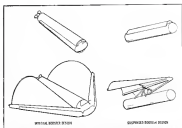
Optimisation costs were calculated and applied as a selection criteria to the most promising configurations. As a result of the study, Bona listed the following design feature recommendations which should be considered for the post-Saturn C-5 launch vehicle:

- **Understeering and instability** of the vehicle. Entire vehicle, rather than engine at stage, should be recovered.
- **Vehicle should be capable of achieving orbital velocity with a single stage.** Single-stage vehicles, compared with multi-stage boosters, offer higher reliability, need less ground checkout equipment, require development of only one set of tanks and engines, and require no stage separation.

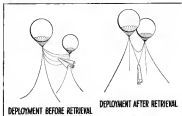
• Liquid oxygen-liquid hydrogen propellant should be used with a higher performance engine than is now available. High chamber pressures of 2,000 to 3,000 psi should be used in conjunction with a nozzle having optimum expansion ratio between 150 and 240 to 1. Ratio of liquid oxygen to liquid hydrogen also should be increased from the present 5 to 1 ratio to 7 to 1. Structural ratio (solid) is 5 to 1.

- Liquid hydrogen tanks with an external insulation appear most economical. Hydrogen vaporized during ground hold operations could be collected and re-liquefied at a significantly lower cost than that of insulation needed.

- Beaded sandwich construction with titanium skins and aluminum core is suggested for the skirt and interstage area, and a glass fiber core with the same outside skin construction for the crown and bulkhead tanks.



**TWO PARALLEL CONCEPTS** for stress of large space booms for crane are depicted in drawing. Version at left shows adjustable pingers as part of boomer structure. Version at right shows pingers attached to boomer by struts.



**INTERVAL SYSTEM** concept is recovery of boaters that parachute return through earth atmosphere is slow. Two 200-ft balloons with nets open would snag boater. Balloons could then be towed to recovery site and lowered to retrieve boater.

Suggested tandem booster with integral liquid-fueled engines would be 100 ft long, 10 ft in diameter and 100,000 lb in weight. A thrust of about 10 million lb could propel a 100,000-lb payload into low earth orbit, according to them. Such a booster would weigh approximately 14.7 million lb at lift-off. Booster would be mated close to the launch area and transported with crawler to the launch pad.

Douglas study discussed the idea of rigid-wing aircraft, since the wings of 1 million lb would require 100,000 lb to launch into orbit. It would take 100,000 lb to launch into orbit. It would take 100,000 lb to launch into orbit. It would take 100,000 lb to launch into orbit.

For a reusable system, Ross offered as one approach an aircraft-like booster, reusable blunt-body drag cone, proposed by Douglas' Biont vehicle.

The rose rose becomes astatistically buoyant at 2,906 ft and settles gradually to the ground as the hot gases inside the rose cool. Recovery, according to Bono, could be made within a 30-m dia. circle 98% of the time, either on land or water.

Another recovery system, an inflatable parashield (AW Oct. 8, p. 12), was outlined in a report presented at the conference by R. F. Modine, Space General Corp. Setting of the parashield system for recovery of the Sirtam C-5 booster was performed in the study, but Modine indicated that the parashield-recovery concept appeared equally

Space-General studies have shown, Brakley said, that one method costing less than 10% of the booster burnout weight is worth considering, even at





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## Solid Rocket Thrust Vectored by Jet Tabs

By Irving Stone

Stability of a jet tab vector for thrust vector control in large solid propellant rockets was established during the recent firing of a 300-in.-dia. motor at Aegion-Gomard's facility here. Firing was the fifth B024x solid to be tested (AWG 22, p. 15) by Aegion under the Air Force's large rocket motor program.

Previous thrust vector control schemes used by Aegion and other companies for large solids under the program has involved rejection of a fluid, cold nitrogen hydrazine, into the exhaust stream to divert the stream in the general direction of impulses.

Aegion motor was a 42 ft. long, four-segment unit developing a maximum thrust of about 150,000 lb. The jet tab scheme used for thrust vector control was a configuration consisting of two semi-circular tabs located 90 deg. apart, at the end of an inboardly operated arm at the nozzle exit plane. Rotation of the arm inserted one of the tabs into the exhaust jet stream deflection away from the tabs. In a flight configuration, this would direct the rocket for a new heading.

Tab motors were selected from a group of four previously tested as a 30,000-lb.-thrust subscale motor, which operated for more than 14 min. One of the tabs, 4-in. thick, consisted of graphite attached to a steel backing. Second tab, high-velocity, was composed of graphite ducted with a thin tungsten facing.

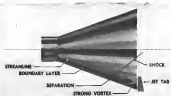
Both types performed well and each was in the gas stream for approximately 50 ms. Results indicated that side loads were more than adequate for expected first-stage booster control, and that there was a relatively accurate linear relationship of side force to blockage area.

Tungsten faced tab did not erode and avoided no change in side force with time. Side force with the monolithic graphite tab dropped only slightly.

Acceleration limits was sufficiently low to indicate that vectoring using gas pressure in the hydraulic system.

Another feature of the 100-in.-dia solid stage was an aft guidance system. This involved a 15,000-lb.-thrust rocket motor mounted on an extendable stand immediately behind the 100-in.-dia. test motor, so that the nozzle of the smaller unit was made the larger one. Directed at the end of the 100-in. motor, the smaller motor's flame reflected burning in the large motor within an acceptable period.

Igniter motor and stand was blasted about 100 ft. downstream, according to



CROSS-SECTIONAL schematic view shows effect of insertion of jet tab into nozzle exhaust jet. Same direction of stream for thrust vector control.



ROTATABLE ARM (white, barrel-shaped component) is shown with jet tab extended into nozzle exhaust jet. Same direction of jet stream for thrust vector control. Right motor is shown inserted into throat of 100-in. solid motor. First of one tab was graphite backed by steel, the other was graphite coated with a thin tungsten sheet. Downstream tab is covered with material to protect against burning.

plan by the exhaust of the 100-in. motor. With flight type landing, the guidance motor would have remained on the launch pad after solid lift-off, thus saving substantial weight in comparison with a conventional spin-on device integrated with the rocket booster at its forward end and moved aft with it after separation of booster.

Test also was used to evaluate a new nozzle design incorporating a segmented-graphite throat insert. Results indicated that additional resistance is required in lightweight, light-weight nozzle functioning for extended burning periods. The throat was composed

of four molded-graphite rings and a phenolic-impregnated, graphite-reinforced located downstream of the graphite rings. The nozzle section was post-baked circumferentially, in the manner of warhead on a belt.

At approximately 60 sec. after ignition, a jet tab developed in the nozzle area above the exit cone was attached to the throat. Motor continued to perform as predicted until about 65 sec. after initiation of burning, when the throat insert was ignited. For the remainder of the planned 120-sec. firing, thrust and pressure were substantially reduced.

# CRUSADERS ANSWER... HOW ARE THINGS IN CUBA TODAY?

Film from the RF-8A Crusader is studied intently by the photo specialists of VFP-62 minutes after being brought into the Fleet Air Photographic Lab.



OFFICIAL PHOTOGRAPH U.S. NAVY

A Chance Vought RF-8A (FPU-1P) Crusader from Light Photographic Squadron 62 returns to the U.S. Fleet Air Station, Jacksonville, Fla., after a photo flight over Cuba during the recent crisis. The RF-8A is the photo reconnaissance version of the new Mach 2 Crusader family built for the Navy by Chance Vought.

The Free World's reaction to the Cuban missile build-up has been a critical factor in the world situation. To evaluate the situation carefully and accurately, it was necessary to have a constant source of information on the progress of events in Cuba.

One of the teams assigned to bring home this information was the Navy's Light Photographic Squadron 62 (VFP-62) stationed at Cecil Field, Florida. In their Chance Vought RF-8A Crusaders, teams from VFP-62 came streaking in "on the deck" daily, far below the scanning limits of Cuban radar. Screeching over the tree tops, they searched out missile sites and photographed them with relentless regularity.

For their outstanding performance, sixteen pilots of VFP-62 received the Distinguished Flying Cross and later, President Kennedy awarded the organization with the first Navy Unit Citation ever made in peace time.

**RECONNAISSANCE AND MISSILE DIVISION**  
**CHANCE VUGHT CORP.**  
A DIVISION OF LING TECH COMPANY INC.

The Navy and Marine Corps Pilots who were awarded the Distinguished Flying Cross, pose with the Commanders-in-Chief, Admiral W. L. Denson, USN, who made the presentations in the name of the President, Top, L to R: Lt. Karl, Day, Foster, Adm. Denson, Capt. Conway, Ltjg. Taylor, Capt. Carden, and Ltjg. Whitlow. Front, L to R: Capt. Lane, Capt. Malton, and Ltjg. Chance.



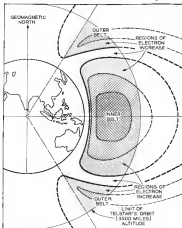
Rear Admiral Joseph M. Carson, Commander Fleet Air Jacksonville, center, with Lt. Gerald L. Coffey and Lt. Arthur R. Day of VFP-62 within minutes after they returned from one of the first Crusader flights over Cuba.

Six of the DFC-winning pilots of VFP-62 pose with Rear Admiral Joseph M. Carson, L to R: Lt. Karl, Day, Foster, Adm. Denson, Capt. Conway, Ltjg. Taylor, Capt. Carden, and Ltjg. Whitlow. Front, L to R: Capt. Lane, Capt. Malton, and Ltjg. Chance.

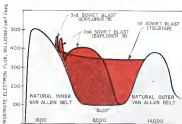


# Radiation Belt Intensity Dispute Grows

By Wanda C. Wetmore



VAN ALLEN BELT diagram shows physical shape of belt where electron flux measured.



APPROXIMATE EQUATORIAL DISTANCE STATUTE MILES  
ELECTRON FLUX plot gives approximate radiation position versus Soviet high-altitude nuclear tests and measured by Telstar and Explorer 35 satellites.

New York—Crew of the disintegration still waiting on scientific results over the precise results of the U.S. July 9 Starfish high-altitude nuclear test seems to be in the threshold of controversy of the radiation-measuring satellites as based the various satellites which sampled the artificial radiation belt created by the blast, according to Dr. Wally L. Brown.

Dr. Brown, head of the Space-and-Defense Physics Research Dept. at Bell Telephone Laboratories in Murray Hill, N. J., discussed the question, following his presentation of the radiation data measured by the ATLAS Telstar communications satellite of the Soviet Union's October high-altitude nuclear blast, at a meeting of the American Physical Society.

The question is, he said, "can one extrapolate anything but a linear direction (i.e., high-energy) spectrum with a nuclear explosion? Apparently yes, from the north of the Soviet test—main, low-energy electrons were released."

Dr. James A. Van Allen, discoverer of the natural radiation belts which bear his name, has criticized the entire report on the Starfish test issued jointly by the Atomic Energy Commission, Dept. of Defense and the National Aeronautics and Space Administration, under the auspices of the Presidential Scientific Advisory Committee (AW Jan. 7, p. 52).

Dr. Van Allen drew his conclusion—which he said coincides with those in the past report—from the Japan satellite, Dr. Brown said. It happened a higher altitude than Telstar and was in orbit before the major Van Allen belt rather than passing into the outer Van Allen belt—so Telstar did. On the other hand, Telstar observations could not distinguish between low and high-energy electrons, according to Dr. Brown.

"However, Van Allen has made a very good point," Dr. Brown said, in stating that "one can't be sure that Telstar didn't measure natural radiation, since it would be orbit before the blast" and hence had no means of comparing post-blast with pre-blast radiation levels. Telstar was launched on July 10 the day immediately following the Starfish test.

Dr. Van Allen has been concerned over what he termed a "false scientific impression of U.S. scientific competence" caused by the past report which stated that the blast gave rise to much more intense and longer-lasting artificial radiation belts than had been

anticipated. Dr. Brown believes that in view of the decision that a conclusion was drawn necessary about the quality of the test and the deepest scientific interpretation of the available data, the report was justified in pointing the blindest possible picture—being conservative—otherwise it would have misrepresented the whole matter."

Dr. Brown pointed out the great upset recognized the uncertainties in publishing the results at that time, as well as the different scientific opinions. This fact, he said, is often obscured in accounts from the report.

## Van Allen Prediction

Dr. Van Allen emphasizes that the results of the blast were "highly unusual" as he had predicted for Mr. Greening, Dr. Brown said, and that, while he had not seen them, "it would be amazing if the predicted radiation increase was enough to break out Ariel and Telstar. These two satellites have been operating normally since the blast."

Telstar was damaged by electron radiation (AW Dec. 5 p. 55), but Dr. Brown emphasized that only a very small fraction of the damage can be attributed to the highly transient radiation resulting from the Soviet shot.

Following the Russian tests, he said, that while there was a linear percentage increase in the intensity of the natural belts themselves, the data between them was virtually filled with enough electrons "swarming from the disturbance." The electron density around Telstar registered a 100 to 1,000-fold increase in the electron count immediately after the first blast on Oct. 22 which nearly filled the valley on the electron flux as expected (AW Jan. 7, p. 52).

Densities rate of 500 per day at the center of the belt at a higher level than before was less in the upper and lower boundaries—presumably due to the resistance of the unrecaptured electron stream which requires magnetic particles into two stable natural electron belts leaving the gap between them.

## Second Explosion

Second Soviet explosion on Oct. 23 again increased the electron density, but gave a very different "spoke" shape to the electron flux profile. The spike was located on the high side of the inner belt at an altitude of about 11,000 miles. The spike measured 300 per cent increase in electron flux (AW Jan. 7, p. 52). Again, it was noted that the radiation level near the center of the belt diminished rapidly, but the spike remained with only a slight decrease from its maximum value of approximately 5 x 10<sup>12</sup> electrons/cm<sup>2</sup>/sec.

Data on the third Soviet shot on

Nov. 3 indicated that only the present spike was created, at approximately the same altitude as that of the second blast.

Electron density on the day decreased more rapidly after the Russian tests than calculations considering only atmospheric scattering—about particles are scattered through collisions with molecules of the upper atmosphere—the dissipative mechanisms would have predicted, Dr. Brown said.

To explain this he has postulated that some unknown dissipating effect works in conjunction with the usual atmospheric scattering. Dissipated electron are presumed to be lost in space and not absorbed by the Van Allen belts, he said, more than was the probable increase in the intensity of the natural belts in the radiation intensity in the day that occurred.

Dr. Brown later stated that it was impossible to determine either the energy yield or the altitude of the Soviet data before from satellite data. This is due to the rapid dissipation of the neutral electrons along the geomagnetic field lines which causes the radiation to become isotropic after a short time.

Thus, an explosion anywhere along the main field line would have the same effect independent of altitude.

Starfish test gave rise to a higher electron flux in the old-500 miles/sec (see at the peak of the outer Van Allen belt when first encountered by Telstar—see Dr. Brown said this can be ascribed to the fact that its high-energy energy probably was released at a



## Welders Complete 280-in. Case

Workers complete the largest U.S. rocket test chamber at the New Shipbuilding & Dry Dock Co. under contract to Aerojet-General Corp. (AW Dec. 25 cont. and p. 73). Case has an overall length of 736.01 in., and an inside diameter of 278.94 in. Pipes and fittings are made of "single post" pipe. Heavy-duty welds make the welding job is made by hand. The case thickens out at the rear where 70 tons of post material are used. The post material is used for the propellant tank & post Telstar, that the job provided his company with the opportunity for the first time to test the ability to fabricate large structures to the close tolerances and dimensional specifications of rocket vessels. Development structure would be made of mating rings—high-strength steel able to withstand 1000 psi heat loads and 200,000 to 250,000 psi pressure. Six hot-dip metal work in manufacturing process, mainly post metal, had contained and all valves, tanks, hot diameters of these tanks have been tested in 100 in. vacuum chamber. Tank from Starfish's development, supercritical pressure in stainless-steel tanks, between pipes, able to hold diameters of the five largest rings to produce a cylindrical structure to have both ends closely parallel. The rocket engine will be transported by heavy lifting gear to the test chamber. Workers at Aerojet-General Co. are, about a year it will be in a good position to build the largest propellant development. At the chamber, Aerojet expects to not only develop development case 1 month by establishing better data on one construction, transportation and manufacturing and loading large quantities of propellant, as well as developing loading equipment.



## Open wide...

And the troops say eh! The U.S. Army CH-43 Chinook designed and powered by the Vertol Division of Boeing, can open its main-deck, 38-foot-long cargo compartment to handle internal loads up to 70' wide x 10' high. Internal loads up to 6 tons can be moved for the Army's standard 192-metric-ton side-saddle hoist. For other missions the Chinook can carry over 7 tons of external payload.

Whether it is personnel, supplies or weapons the Chinook can pick up a big payload and put it down—FAST. Add to this total carrying ability, all-weather, day/night flight capability and ease of maintenance, and you can see why the Chinook will do its job and do it well: for the U.S. Army in the jungles of the Far West. Creative engineering, forward thinking.

weapons system program management and the vast resources of the Boeing Company made the Chinook possible.



difficult position in the geomagnetic field.

Primary changes of the energy spectrum resulting from the added electrons stemming from the Soviet tests had the effect of causing the act-and-spectrum flux at approximately 6.5 msv, with respect to the lower and upper ends of the spectrum.

Radiation level trends. Teletor averaged 100 roentgen greater than had been anticipated. Dr. Brown said, resulting in a lower degradation of the sub-skin, insurance components—generally known as (AW Jan 21, p. 80). Through, no caused by electrons with energies greater than 15 mev.

### Protective Measures

Teletor was raised after the electron induced malfunction (AW Jan 14, p. 82), but to prevent a recurrence of that mishap, Brown suggested the following protective measures:

- Use of a less exposed orbit line that of Teletor, which spent a great deal of its period both in the slot and the near high latitudes. Van Allen built.
- Internal shielding of various components from radiation, but with consideration of the accompanying weight penalty. Extensive shielding of the solar cells a not feasible, but radiation damage to them could be accounted for by including a sufficient number so that a certain percentage degradation in power output over a period of time could be tolerated without lowering the total power below a level where mission performance would be adversely affected.
- Use of different components that are less sensitive to radiation. Dr. Brown asserted that this could involve no insurmountable difficulties.

In another item, he said that he has considered the "plasma-sheath question" of means to double, finite utilities. In addition to destruction by a direct interception with a nuclear warhead, an atomic space vehicle could be neutralized by compressed, long-range ionization radiation damage—a sort of cumulative electron poisoning—which would have the same net effect, minus the thermal contribution of a direct attack. To accomplish this, a satellite would have to stop, high altitude, in close proximity of its target, regular intervals in order to maintain a sufficiently high level of artificial ionization both in the slot and below the near field, but of course this would affect anticipated friendly utilities as well.

Satellites such as Teletor and the Bioglobe could be used to detect nuclear explosions at great, low, and, provided that the latter were not too close to the borders of the geomagnetic trap. If it has not already, Dr. Brown said, this technique should have occurred to the interested parties—presumably the Defense Dept.

## Remember the Flying Fortress?

AN ARSENAL ON WINGS IN WORLD WAR II...



(B-17 in Photo, left; B-17 in photo)

## ...and Barber-Colman was there!

Remember the famous B-17 "Flying Fortress"? These high-altitude, long-range bombers scored an unsurpassed combat record during World War II.

Thunder from their 1,200-hp engines filled the skies over Europe and the African deserts. When adverse desert dust and sand attacked the engines, a carburetor air-intake filter was added, but at higher, dust-free altitudes, pilots saw air directly to the carburetor through a filter bypass. Remote control of the filter called for maximum reliability. That's why Barber-Colman actuators were there... one on each engine.

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# GYROS



This 72-page reference book describes the theory, application and testing of gyros, platforms and accelerometers. It also discusses, with some reservations to protect our proprietary interest, several sophisticated concepts now being developed at Kearfott. It includes, for your convenience and ease, a tabulation of the equipment we produce in these various product areas. A copy of this book is available to you free of charge. Just drop us a note, requesting your copy.



**Stable Platforms.** Essentially a cluster of gyros mounted within a gimbal and a leveling mechanism, stable platforms perform the important function of leveling the gyro and gyro platform by means of a leveling loop. By incorporating various arrangements of gimbals and gyros, a variety of platform types can be produced. They are used as reference elements and to stabilize accelerometers, star trackers, and similar devices in space.



**Rate Rate Integrating Gyros.** Flashed rate integrating gyros are used where moderately high level performance is required. Should the rate error of a gyro when being an angular momentum of 1.2 x 10<sup>5</sup> gm cm<sup>2</sup>/sec, drift by as little as one milliradian, a drift of 0.1°/hr could result. The difficulty in achieving ultra-high precision and accuracy is apparent, and the necessity for achieving low drift gyros is of paramount importance.



**Rate Gyros.** A rate gyroscope is constrained to one degree of freedom, and its displacement about the output axis is proportional to the angular rate input to the input axis. The rate gyro utilizes the phenomenon in which an angular velocity input produces an output torque. A rate gyro is so called because it is used to measure angular rates of rotation about a selected axis. It also provides a means for integrating angular displacement into a vehicle's control system. The most difficult of developing is a function of the vehicle's dynamic characteristics.

**Rate Accelerometers.** A typical force balance pendulous accelerometer utilizing a differential transformer pickup, a high gain output amplifier, and a 90° phase shift network forms a rate gyro. This type of accelerometer, together with its amplifier, also provides a means for integrating the current reading through the force balance coil, measured as voltage across a resistor in series with the coil, is directly proportional to the accelerometer input.



**MINS - Inertial Platform.** This miniature four gyro inertial platform is the heart of our newest Miniature Inertial System (MINS) now undergoing extensive flight testing. Weighing only 14.5 pounds the MINS platform contains three KING II Flashed gyros and two single rate force balance accelerometers. Through major improvements in platform configuration and flashed gyro design, this platform features a record warm-up capability - fully operational in five minutes from -55°F. Modular design of gimbal components and azimuth gimbal cluster permit ready modularity at minimum cost for a wide range of aircraft, missile or space vehicle applications.



**KING II - Flashed Rate Integrating Gyro.** Major improvements in the proven KING gyro have made possible this second generation instrument featuring high load torque stability, pick-off scale factor at 1.6V and mass imbalance shift 0.05°/hr (1) signal maximum speed. This outstanding mass stability eliminates the need for daily burning. Short-term drift in azimuth and vertical is 0.05°/hr based on standard deviation in one hour run suitable for storage in a wide temperature range. The KING II gyro is ideally suited for the most severe application. Other KING gyros are also available featuring high torque, high spin and resistance to shock and vibration. Three KING gyros provided the mid course steering signals for the recently successful Mariner Venus fly-by.



**Inertial Single Axis Accelerometer.** This single axis, fluid damped accelerometer is a DC torque-restrained device possessing a useful dynamic measuring range of greater than twenty g's. The sensitive element consists of a symmetrically located differential transformer pick-off and a pair of force coils mounted in common on the instrument measuring axis. The high degree of symmetry of both force coils and pick-off coils minimize the resultant errors which might otherwise occur during vibratory inputs. Transformed amplifiers, such as the Kearfott type 33503 D1A, are available. Typical characteristics include: Range of measurement... 20 g when using 53003 amplifier (100 g possible); Bias and Zero Stability... 0.00003 g/day; 2 x 10<sup>-4</sup> g; Natural Frequency... 300 cps.



**Subminiature Fluid Filled Rate Gyro.** This fluid-filled rate gyro combines high performance and reliability with subminiature size and minimum weight. Minimum initial uncertainty, low hysteresis, low acceleration sensitivity, and constant damping without use of heaters are achieved without the production difficulty and increased cost usually associated with this type of inertial device design. Consisting of a pick-off, float, and deeper as the main subassembly, reduces the number of basic components. This rate gyro can be used in a great many applications, including infrared trackers, target seekers, missiles, attitude control systems, solar stabilization, tele-measuring instruments, and rate measuring devices.

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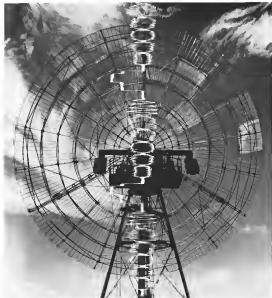


Bell X-5 rocket plane is carried in a USAF C-119 to 3,000 ft. altitude before being dropped onto Gary Army Air Field near San Marcos, Tex. Test was part of a program to develop soft landing techniques (AV Dec. 3, p. 44)

## Soft-landing Techniques Tested for Mercury



Rocket motor was ignited by extended probe when parachute broke; craft was about 6.5 ft. from ground. Motor provided 5.2 g. deceleration for controlled landing. Rocket motor port is visible above right in center of capsule's first shock.



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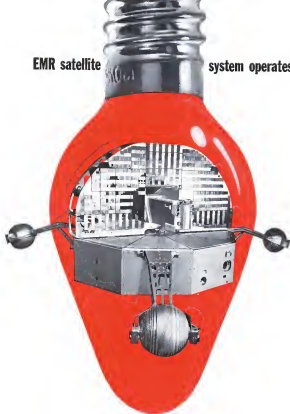




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... and is destined to set new reliability records for the next generation of spacecraft. Unique components designed for microvolt operation ... quad-redundancy at the circuit level ... industry's most demanding regime of progressive testing ... are major factors contributing to this technology. EMR calls it micropower.

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These techniques have been used extensively in the PCM telemetry systems supplied to Ball Brothers Research Corporation by EMR for the NASA S-27 Orbiting Solar Observatory.

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- Pedigrees on each component, show performance, establish component life histories pinpointing weaknesses.
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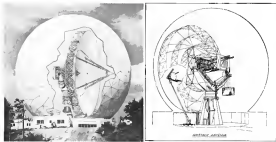
FINAL CONNECTIONS under the EMR micropower system. Components are described. Before final tests, more than 80% of the components can be self-inspected. Before final connection, no single component can cause a system failure.

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CUTAWAY DRAWING on Haystack radar shows relative size of parabolic reflector antenna. Left: Metal cells right is shown being used by feed to position. Metal cells consist of RF equipment to allow quick changes and variable downtimes.

## Haystack Will Advance Radar Precision

By Philip J. Klein

First designs of the Town's new Haystack facility, the most advanced installation for spacecraft tracking, space communications and radar astronomy in the non-Communist world are going into place at Lincoln Laboratory's MIT dome. MIT faculty near Cambridge, Mass., initial selection years ago selected for this summer with full faculty operations scheduled for the end of this year.

Haystack is expected to have the capability of tracking a target the size of a dime at a distance of 1,000 mi. It will be the first Western radar capable of making contact with more distant planets, such as Mars, Mercury and Jupiter.

Haystack will be a versatile facility. It can track distant spacecraft while simultaneously exchanging information with the vehicle, at it can track the spacecraft from its reduced beam signal. Additionally, Haystack will be used as a ground terminal for both passive and active communication satellites experiments and for radar astronomy.

Haystack is being built under the sponsorship of USARP's Domestic Science Division, Bedford, Mass., and will be operated by scientists of the Massachusetts Institute of Technology's Lincoln Laboratory. Facilities is expected to cost nearly \$16 million.

The 120-ft dia parabolic antenna with 120,000 ft<sup>2</sup> in combination with low noise receiver, is expected to

make Haystack about 2,500 times as sensitive (34 db) as the early MIT dome. Half radar, plus it is a large which is a space based in great. The MIT dome. Half radar is one of the first to make contact with Venus several years ago when the planet came within proximity of the earth. Haystack should be able to contact Venus throughout most of its orbit.

At an operating frequency of 27.5 (g. sec.) the 120-ft aperture of Haystack should produce a beam which is only 0.001 deg wide compared with the 0.04 deg beam width of the large British radio telescope at Jodrell Bank. Translated into resolution possible on the lunar surface, Haystack's antenna will discriminate as seen from a distance of about 275 mi., compared with 4,500 mi. which the Jodrell Bank antenna would view.

Swain Thomas's Lincoln Institute has a 75-ft parabolic antenna at Serripedon, which is expected to have a beam width of about 0.027 deg at 15 g. operating frequency, but so far it is known it is a radio telescope, not a radar.

Full 120-ft aperture of Haystack is intended for use over a frequency range of 5 g. to 10 g., and the near 60 ft of the reflector is expected to be fully over the surface and not allow it to use up to 55 g. perhaps even higher.

An equally important characteristic of the antenna was the direction of the Haystack beam can be directed. Design objectives call for an accuracy of 0.001 deg under dynamic

conditions (frequency is required). The 160-ton antenna, riding on a 14-ft dia. sliding bearing will be able to move at rates up to 15 deg/sec both in azimuth and elevation.

To permit maximum utilization and flexibility without long periods of downtime of the expensive antenna, the transmission and reception are mounted in a 5 x 5 x 17 ft. metal cell which can be quickly dismantled and replaced with another cell containing different equipment.

Because Haystack is an experimental facility and because of advances in technology, the complement of equipment to be installed still is somewhat fluid, according to Herbert G. Weiss, assistant head of Lincoln Laboratory's radar division.

Most improvement in sensitivity provided by Haystack radar is expected to use a wideband radar and possibly more sophisticated signal shaping (pulse compression) of the transmitted pulse to obtain more information about the target from the reflecting signal. Haystack can substitute both horizontally and vertically polarized signals using elements in the polarization of the reflected signal to obtain additional information about the target.

Far use in tracking passive satellites or low altitude non-cooperating spacecraft, Haystack will use an X-band monostatic radar operating at 3,670 m with provisions for variable pulse length and repetition rate. Power output on both will be about 2500 kw average.



SEE OF THE HAYSTACK 120-m. parabolic reflector's supporting structure is shown as it is constructed at North American Aviation's Columbus Day plant.

but this figure may be doubled with the coming of higher power electron tubes for radar receivers, more distant spacecraft and for space communications. These will be a wave-powered transmitter operating at 7,750 m, using four 100-kilowatt electron tubes to produce 100 kw average power. In power tubes should permit this figure to be raised to 200 kw or 300 kw.

When this wave transmitter is used as a radar it will have a bandwidth of 30 mc and will be able to generate 100 microsecond pulses with the resolution changed perhaps even 20 microseconds during the pulse.

To receive signals from the two-pass, non-coherent radar transmitter Haystack will be equipped with four parabolic antennas coated by a thin portion of 0.001 in. with an overall surface finish integrated at less than 100K. Two of these will be used to amplify these signals one horizontally polarized the other vertically polarized, while the other two will amplify different signals one horizontally polarized the other vertically polarized.

As amplifiers for the wideband, higher power radar, Haystack will use two wideband parametric amplifiers for the downlink and another difference signal, and two corner cooled to 20K for the two wave channels.

Recent advances in parametric amplifier technology at Lincoln Laboratory and Bell Telephone Laboratories indicate that a parametric amplifier cooled to a 20K temperature can provide performance comparable to a tunnel diode and complex. Lincoln Laboratory may decide to select the improved parametric amplifier for the original system.

Haystack antenna required construction techniques similar to those used in building bridges, but the facility does present a precision which challenged

the manufacturing and inspection rigorously even of a company experienced in building expensive aircraft-North American Aviation's Columbus Day. For example, the reflector is fabricated from 60 individual panels made of half-inch thick aluminum honeycomb, each of whose surface contours must be held to within 0.01 in. These are fabricated into an integral shell by means of circumferential cables under tension. When installed the center of the 120-ft. dish must be held to within 0.075 in. over its entire surface, despite ambient temperature changes and shifts in structural loading when the huge dish changes its elevation among angles.

Although the reflector is fabricated entirely from aluminum, and the antenna structure is made entirely of steel to avoid thermal distortion, both metals will creep at various rates below

elastic limits. This can produce small distortions which would adversely affect Haystack's performance at higher frequencies.

Lincoln Laboratory scientists considered that the precision demanded of Haystack required a far more detailed stress analysis, under a variety of temperature and loading conditions. This could be achieved using previously available hand-calculations techniques. However, both North American and Lincoln Laboratory developed, side products, computer programs in which the antenna could be designed and checked with far greater precision. The Haystack antenna was redesigned 12 times by computer before the design finally was frozen, according to Weiss. North American then built a 17-ft dia scale model and subjected it to tests to confirm the computer design.

To assure that the antenna remains in precision during use, a microwave interferometer alignment system has been built into the reflector. Small diodes permanently embedded in the reflector will be excited at a frequency of 5,400 mc and the relative phase of signals at such diodes compared with direct signals in reflector center as well as 0.001 in. Additionally, an optical alignment system can be mounted below the feed point of the antenna for calibration against several hundred optical targets marked on the surface of the reflector. If distortion has occurred, the tension on the microwave cables can be adjusted to restore the optical center.

To protect the antenna from New England's harsh winter winds and ice, it is housed in a 190-ft dia. dome, constructed from 0.04-in. thick aluminum plates fitted with an aluminum framework. Measurements indicate that the ice introduced by the marine will



SUPPORT YONE for the Haystack antenna is shown at the North American Aviation facility. First elements of the antenna have been shipped to Lincoln Labs' MIT site.

**ACTION MEMO**  
**FROM:** Design Engineering  
**TO:** JMH. Sept 27-52.

*Look at the size of that blond head! Didn't this the answer to whether edges and dimple applications? Let's evaluate this now!*  
 JMH

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and covered weight 8.7 lb. These will be as strong as titanium. Temperature ready the cables, except that the metal is covered to prevent buildup of thermal gradients and heat will be generated to keep interior temperatures above freezing.

North American aircraft delivered in the 1950s are the C-119B, a twin-engine transport, the largest of its kind ever produced and the 100,000-lb cable which will support the aircraft. The latter is scheduled for delivery in the late 50s. More than two years of planning with some logistic departments and railroad representatives are involved in providing track and rail transportation for the large elements. North American reports.

Transportation for the Hercules facilities are being built in Redwoodland and some of the pneumatic air pipes are to be supplied by Titan Instruments. Other pneumatic supply lines and the various are being developed on an on-going basis in Lincoln Laboratory. The cables are supplied in 10 ft. Thompson Fiber Glass Co.

### NEW AVIONIC PRODUCTS

• **Magnetic base differential transducer**, weight 61 gr., has sensitivity of 101  $\pm$  per cent of nominal bias into



a 100K load when coil is excited with 5  $\pm$  to 400 cps. Device has bandwidth of 0.1% and operating range of  $\pm$  0.005 in and operates over frequency range up to 500 to 2000. Magnetic shielding is provided. Manufacturer: Magnetic Timing & Controls Inc., King of Prussia, Pa.

• **90 watt Zener diode**, Series 1N2549 to 1N2549B, in collages from 6.5 to 700 mil and tolerances of  $\pm$  .10 to .20% is packaged in standard TO-18 miniature case. Application details are in catalog in data sheet P-30. Manufacturer: Dulco Electronics Corp., 245 S. W. 30th Lane, Scottsdale, Ariz.

• **Variable printed circuit connector**, called Snap-Lock, can be assembled in one closed length and members of unit members using two standard of members and optional members of standard blocks which are locked together in



series of steel side plates and two inserts. Connectors designed to accept a four based, can be composed in series, then snapped into place in the snaplock Connector itself is 0.150 in thick. Manufacturer: National Connector Corp., Science Industry Center, Minneapolis 35, Minn.

• **Random-access strip-file projector**, Model 111, has capacity for 112 frames of 15 mm film, can locate and project any single frame within eight seconds.



Projector can be operated from variety of inputs including keyboard, telephone, and computer buffer. Projector can scan about 5 cm. in, occupies 680 watts of 115 v. a. power and has an 1/10 sec with a 14-in. focal length providing resolution of 33 lines/cm. of the film. Manufacturer: Minuteman Corp., 2711 E. 17th St., Des Moines, Iowa.

• **Compact transistor holder**, Type KTC-400-LT, made of nylon, provides



four gold-plated brass legs, each extend only 4/60 in. below body, for high die on packaging. Overall length of

project is 0.125 in. Manufacturer: Solid-state Corp., 179 East St., Milwaukee, W. Y.

• **100mc logic modules**, for use in electronic, control logic counting and other pulse counting, include logic, logic, function discrimination, multi channel coincidence circuit, a fourfold boost and a work. Modules measure 94 x 42 x 14 mm and are designed for operation at 100 cps operation. Manufacturer: General Applied Science Lab, Columbia Inc., Merck & Stewart Avenue, Westfield, E. I. N. Y.

• **Frequency air measuring network**, called Air-Sens, can add unlimited number of collages with accuracy quoted at 0.007% operates at frequencies of 10 cps to 5.12, and is available with output impedances of less than 900 ohm at 1 megahertz. Units can be tailored to customer requirements. Manufacturer: Schenck, Inc., 1231 So. Midway Blvd., Pittsburgh 10, Pa.

• **Highspeed test-recorder**, Model 2425, automatically measures dc collages in precision of 0.01% at rates up to 1,000 readings per second and records measurements in digital form on magnetic tape. Standard type format is directly compatible for use with IBM 7090 computer. Manufacturer:

Non Linear Systems, Inc., P. O. Box 728, Oak Mills, Calif.

• **Magnetic parts vibratory feeder**, called Micro-Inc, for automatic handling of fine parts, can feed, mix or



and produce each part at rates up to 10,000 per hr. Micro-Inc has a capacity range of size from 24 to 12 in., capacity from 117 to 2 cc, fill rate. Manufacturer: Affiliated Manufacturing Inc., Box 101, Concord, N. J.

• **Balanced control mixer**, Model 594, provides 20 db isolation typically between RF and local oscillator signals, with 15 db isolation at band edges. The VSWR for both is 2.1 maximum and the noise figure is 7.5 db, or 6.5 db less with special crystals. Manufacturer: The Naval Microwave Corp., Plant One, E. I. N. Y.

### PROBLEMATICAL RECREATIONS 156



From a point P outside a given circle, construct a straight line through the circle, perpendicular to a given diameter of the circle.

—Continued

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## Army Tests Pershing-Chinook Compatibility



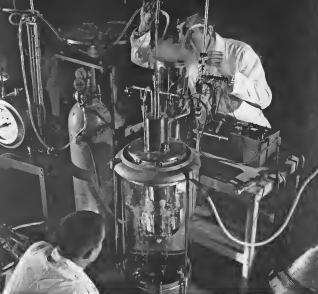
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MST team truck, above, on helicopter strip landings below and which for so long provided access to transport to the launchers. A new dual engine and pressure combination fuel air system at left. Below, an empty transporter rocket launcher weighing 5,500 lb. is prepared for loading into Chicomulco. Tests checked clearance, freedom and weight and balance compatibility.

[illegible]





## Beech helps space vehicles get better mileage by turning "hot" fuel into icy slush

### *Slush hydrogen experiment shows vital facet of Beech's comprehensive systems management capability*

At the heart of this experiment at Beech's Boulder, Colorado, space center are three double-walled vacuum jars, each inside the other. Inside the inner jar is liquid hydrogen, while the center jar contains liquid helium. The outer jar is filled with liquid nitrogen. The idea is to further reduce hydrogen temperature until it turns to icy slush.

The purpose of this experiment is to explore the feasibility of reducing hydrogen volume in order to increase space vehicle fuel loads without increasing tankage size or weight.

Applied research projects like this are common at

Beech. In the past they have included vehicle work on cryogenic problems, space environment, and countless other projects that have measurably advanced the state of the art.

Basic research and development is but one of an ever-expanding group of Beech space-age capabilities. Within the last year alone, the size and function of Beech space facilities has more than doubled. This constantly expanding capability complex, coupled with a highly trained and experienced staff, makes Beech a natural choice for systems management projects. Besides the experiment shown here . . .

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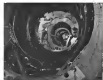
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MODEL 1121 JET COMMANDER retains traditional Aero Commander look despite different wing placement and new-mounted jets.



JET COMMANDER IS ROTATED during Valsparc test runs prior to first flight. Rotorcraft speed was 90 mph.

## Twin-Engine

By Brian J. Ballou

Norman, Okla.—Aero Commander Model 1121 to replace Jet Commander announced approximately 21 hr of flight time and made a number of landings and takeoffs during the start of its flight test program here at the company's research and development center Jan. 27.

First flight of the initial prototype was planned two days earlier, but the schedule was interrupted by a malfunction in the a.c. electrical system preventing the auxiliary hydraulic pump. The system is installed only in the prototype; the production configuration will utilize engine-driven hydraulic pumps.

Two engine bypass systems generated 12,788 lb. on its first ascent compared with normal lift gross of 14,000 lb. It took off in approximately 1,800 ft. Test Pilot Wendell Dobbs programmed a 90-knot maximum speed and altitude occurred at approximately 100 kt. Climb to approximately 10,000 ft. was made at a climb rate of 340 ft./sec. Initial flight was to hold at 10,000 ft. and not exceed 700 kt. in the course of checking general handling characteristics.

Landings and takeoffs with and without drops were also made.

Flight test program calls for approximately 10 hr to be conducted at Norman. The airplane then will go to Mojave, Calif., for more extensive flight test program; it will require its performance and flight characteristics trials.

It will be followed by Mojave in approximately three months by the second flight test program, which will be used primarily in checking out design, instrumentation, air conditioning and other systems. A third schedule will be utilized in static tests.

Number four will be a full production configuration and will be utilized in the company's documentation. Number five airplane will be the first customer airplane.

## Jet Commander Begins Flight Test Program

Company had 18 orders with total deposits of \$25,000 each, ensuring production line position for the Jet Commander prior to its first flight. It is expected that this will increase, since a number of projects have been holding off pending documentation of the actual system. Schedule calls for delivery of the 11th airplane in late 1984.

Although company officials are reluctant to discuss development costs, Aero Commander probably will have invested more than \$6 million in the program, including research and tooling up to the time it starts building up actual inventory for production. Production assembly jigs are now under construction, and employment has increased from approximately 750 a year up to 1,150.

Sales are being made on a direct factor-to-customer basis, with the initial \$175,000 deposit setting a firm production line position. A second payment of \$110,000 is required six months prior to delivery.

Price for the basic configuration is \$475,000, although specific customer specifications for electronics and other features could increase this to approximately \$480,000, depending on option. The first payment would be made on delivery.

Aero Commander plans to provide customers with a complete warranty covering parts replacement, repair and labor with General Electric supplies of the airplane's 2,810 hp-thrust C610 turboprops, and other supplies handling their own warranty programs.

Aero Commander's last-even point on the Model 1121 probable will be between 75 and 100 airplanes.

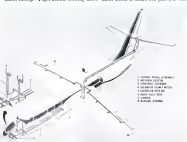
The company is planning to handle a greater portion of the Jet Commander fabrication activities than normally considered. For example, complete wing assembly will be done at the company's Buffalo, Okla. production facility instead of being subcontracted.



DIAGRAM, above, shows Jet Commander electrical system, below, hydraulic system.



NAVIGATION AND COMMUNICATION equipment exterior, above, shows radio aids in center fuselage. Flight control driving below, shows layout of cables and push-pull rods.





selection and a schedule, program will have been started in preparation for the Sea Knight program. When WKRP has initiated the support programs were expanded and combined under the direction of Thomas F. Bagley, supervisor of the Maintenance and Support Analysis Unit.

Bagley's unit has the responsibility of providing Navy with the data and maintenance analysis documents and for coordinating the efforts of all supporting activities within the program. A man against task benefit within Vought has been a driving together of the different systems, which previously operated more independently toward the same goal. The integrated maintenance organization within the company is a flexible, functional unit, composed of the management structure, but it has functioned smoothly because of cooperation between activities.

#### Engineering Analysis

In May, the engineering analyses will be used on a CH-46A in actual maintenance, crew will perform the scheduled tasks to make the tests, questions and answers.

Grumman's A-10 was to have been converted to the integrated maintenance program, but Navy decided against making the amount of funds required to conduct an analysis of

the aircraft a complex information.

Contractors formed an integrated maintenance management team, made up primarily of experienced maintenance engineers, to handle the other company contributions, but the group has run into some problems. A technician has been selected for his on the 1-111A/F light.

The 1-111A/B will be the first response vehicle to be fully converted to the integrated maintenance program, but because of the crew and Navy regulations and personnel ratings, an not compatible a great plan called Maintenance Program Requirements, are developed. From Navy a point of view, however, it will save the latest progress in the integrated maintenance plan. Maintenance, which Navy would like to make, at least to design to weight determination, should be affecting only design considerations.

United Aircraft's Sikorsky, also has an integrated maintenance management plan for the CH-46A, recently selected by Navy for Marine Corps use in a heavy transport helicopter. Sikorsky's plan resembles that being used by Vought, except that the program coordination is responsible to the program management office.

The increasing complexity of systems is being presented by a new maintenance support program. A

percentage maintenance program has been developed to schedule, periodic inspections and regulate the use of aircraft out of commission for maintenance.

Unscheduled maintenance, then posed a problem, since lack of component availability data would preclude of non-percentage maintenance, difficult and affected the inspection scheduling.

Some inspections were, too closely spaced and had caused up for inspections before, current very important engine components. Other components failed just before the inspections were due, indicating that if not continuously could be predicted, replacement could be effected in a scheduled basis.

#### Inspection Schedules

Contractors holding Navy aircraft were, asked to analyze their aircraft to make the inspection schedules and if possible, to predict component behavior.

Analysis was conducted on the Douglas A-10, A-10, Grumman A-10, Long-Tech-Vought T-5A (1-111A), Lockheed P-3 (P-3V), McDonnell F-4 (F-4D) and North American A-1A (A-1).

Navy department from the studies that it was not having inspection analyses properly, could not determine the cost of the maintenance program and was not using the correct form for presenting its maintenance program.

## DOD, NASA Study Common System For Rating Company Performance

By William H. Gregory

New York—Contractors studied for a contractor performance rating system is being sought by Defense Dept. and National Aeronautics and Space Administration in a step in making such rating a key element in evaluation of future research and development proposals.

One of the key factors in rating contractors will be comparison of previous performance with actual results, according to Greene G. Brownstein, deputy assistant secretary of defense.

Business concerns over the implications of such a system was plan during a panel discussion on proposals at the 1969 annual meeting last of the both the of the Aerospace Sciences in scheduled by, questions directed at Brownstein and Ernest Brackett, director of NASA's Procurement and Supply Division, also a panel member.

#### Report Cards

Those dealt with objectives of the rating system, geographical or political factors is a factor, whether contractors would go report cards with no consequences for companies, and whether the performance rating system would take into account the amount of work involved.

"Procedure is far from complete," Brownstein said, "and the same number may be used to see whether there will be some sort of report card, but not government—Brownstein gave—100% for this will be."

Contractors and such information probably will become part of the public record. However, it will be sought by congressional groups and others. Brownstein said, there might be as well as single procedure for making it available.

Brackett did not completely support the view that the data would be made available to Congress and the General Accounting Office. For example, it would not be automatically disseminated public information.

#### Risk Evaluation

High-risk, lower risk contractors have been awarded. Brownstein said, but focusing on comparison of results with previous should make contractors in this matter.

"In high risk situations," he said, "contractors should take into consideration and not provide the basis. The basic course of rating will be how the program did from one compared to how very last it would have out.

"Nothing in the program should be used to discourage pioneering efforts. But we shouldn't just even little engineering job in pioneering," Brownstein said.

NASA's view of the system, as described by Brackett, did not favor a formal report card approach which would result using a grade expressed in percentages or letters.

"It should be an objective, factual report," Brownstein said. "It shouldn't be a high number, but an of time and produced a superior product, the report should be an."

Brackett said the contractors should also be allowed to have the system as well. But it is the question of whether the contractors could be completely convinced of the objectivity of the rating, Brownstein commented.

"The rating would be arrived at by negotiation," he said, adding that wouldn't say who companies have difficulty in understanding that the government, like any buyer, should take the people it does business with.

Brackett said performance, both in technology and in working delivery, evaluation of proposals will also take into consideration such and the contractor's management capability, Brownstein said.

During the course of a contract evaluation, he planned at intervals of six months and at the end to help provide a meaningful score for future use according to Brownstein.

#### Labor Surplus

Geographic considerations are not of major importance in A-10-type source selection, both Brownstein and Brackett said. Surpluses are provided for labor surplus areas in procurement of supplies, personnel are contractors, but not in A-10, where finding the right technical capability is of permanent importance.

"When contracting for A-10," Brackett said, "we have to go to the company that will do the job. If two companies were quite equal and one was in a labor surplus area then the contract probably would go to the labor surplus area company."

The task for the system "Proposals—A Question on What?" brought the general response from the participants.

"Yes, they are both," Major industry complaints dealt with the so-called "weed" argument for proposal, would to give the men of open competition. In such cases, the competition actually was the company the contracting agency wanted to do.

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## March 11, 1963

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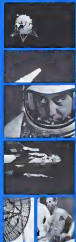
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**ELECTRONIC ENGINEER (Signal Design)**—to conduct research for hydrofoil systems (transducer low frequency noise application for commercial and hydro space product applications) and hydrofoil gear (existing for digital data systems, such as rocket shafts and equipment, display and data processing equipment). Provide schematics and follow through testing to verify these designs and create control data.

**DESIGNER (Technical Services)**—to establish technical standards for product design/development regarding use of standard parts and component vendors, senior design inputs, conduct technical audit of engineering concepts, establish test programs, analyze data to evaluate performance of parts. Should be familiar with AS, ABS and RAG standards parts. Be able to conduct various related analytical design studies.

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**ANALYTICAL ENGINEER (Thermodynamics)**—to conduct studies involving AIC, ducts of thermodynamic transfer, duct systems associated with complex mechanical devices, heat transfer systems analysis (propulsion controls, temperature control devices, etc.) and equipment. Conduct theoretical analysis along with experimental research, with opportunity to test up test projects to support present and future development in research group.

**ANALYTICAL ENGINEER (Fluid Dynamics)**—to conduct theoretical and experimental research studies in fluid dynamics (fluid transfer) associated with space craft environmental conditioning systems, associated systems and processes. Should be familiar with properties of gas properties, fluid up experimental test projects to support program objectives.

**SENIOR STRUCTURES ENGINEER (Mech.)**—to conduct analytical studies on the effect of static and fatigue strength and behavior of structures and structures (pin, control) and direct efforts in experimental work involving static, dynamic and fatigue tests (stress, strain, and stress) and design of prototype systems and full-scale systems of aerospace propulsion controls and other aircraft systems. Requires ME degree with strong knowledge in field of structural analysis or degree in Metallurgy with strong background in mechanics.

## Cost Estimates

Cost estimates are proving as tough a problem as the National Aeronautics and Space Administration in there are to the industry and NASA is introducing a new governmental regulation in an attempt to cure one phase of the problem.

At Ernest M. Rockett, all the year system, explained in an IAS panel on proposals.

"What we are doing to regulate the contract with a program, we are often presented with a cost and proposal made greater than the original estimate. Usually, this is due to the fact that the cost is not based on NASA changes."

Under the new regulation Rockett told the original cost estimate must be the basis for negotiation.

Any changes must then be passed on individually.

It is the first place in a sub-system procurement, the other contractors feel.

Another complaint involved other places of hidden money of which most have the capabilities required for the job.

Robert Chapman, vice president and executive vice president of Aerojet Associates, Inc. disclosed some \$40,000 programs with as much as 110 hidden costings. Chapman supported the industry system, giving considerable company in industry and government, in a solution.

This calls for a wide open first-stage competition for all costs—existing or new. The industry has the capability to produce a wide variety of products and perhaps push technical progress. On the basis of these proposals a lot of first budgets would be selected to provide using unique because technical and perhaps cost proposals.

## DOO Objectives

Members of the nation call for sub mission of technical proposals that, with its cost modeling as technical means only, a fair submission of cost proposals.

Firm BDO's standpoint then, its objectives to the two step system. The nation and.

Although the nation is being tried it is not being attempted to the extent the nation has tried.

"There is still much problems, political and practical," BDO's said. "It is too big, a quick and dirty first stage and break out 10 potential contractors."

"It is not just, you have not created a political position. You have kept some of a chance to win."

"In having a quick and dirty first stage and trying this one is best quality look, you may also be breaking off some

gas who may have the best idea. Research as a window a contract to a company, which would have been broken out in the first stage of a two step competition, but a time when on development turned out to be the most appropriate and required."

## Increased Fee

Another plan put forward to eliminate, rethink and only proposals is to allow proposal costs at all but to increase fee or profits as a basis of compensation.

Companies then would be spending their own profits for proposals.

BDO's divided whether such a system would be nullified from the present cost of proposals.

Some of the cost, he said, would be lost to its own other costs and make the problem of overall control that much more difficult.

Work is not as inevitable consequence of proposals, the panel felt, but there is an aspect in the cost of proposals. BDO's described one proposal to NASA that weighed 100 lb. and another for its cargo plane, only for the least expensive model (LEM) that cost over \$720,000.

"Speculation," he said, the solution of expensive models were discouraged as much in winning contract competition.

"I'm not sure, it will ever get to an RFP, it would not be accepted," BDO's said, but we want it in our case that it will ever be fairly better findings, but I can assure you this, it won't help."

## Industry View

How much money in money and effort is required for proposals that was indicated in the panel chairman, John H. Schuchman of Radio Corp. of America, on the basis of a preliminary RCA survey.

• To maintain the same proportion of money. RCA has had to increase the number of proposals made 100% in its last two years.

• Reputation on regulated price procurement has increased 140% in the same period.

• Incremental funding has reduced the number of dollar value of each contract awarded 17%. Subcontracting required for subcontract relative to the balance of incremental funds has also raised staff and administrative costs, according to Schuchman.

• Increased level of review in government has raised costs 40% in the last 10 years.

"It's costing a lot more to do business with the government these days," Schuchman said.

"At the same time changes in government regulations are making it tougher to recover these costs."

Expanded responsibilities as prime contractor and systems integrator for the SSG Standard Space Launch System

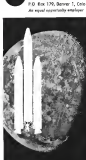
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## INSTANT LAUNCH



Will space vehicles of the future be launched on a ready-to-go basis? "Yes," says Robert A. Bailey, chief spacecraft engineer of Lockheed-California,

"Refinement of current launch procedures is inevitable in the years ahead if we are to achieve greater efficiency for America's space assets. New technologies in spaceflight tracking are essential. We are to rendezvous with manned space-based vehicles."

As visualized by Lockheed California scientists, automatic launching of "light ready" probes depends on completing a maximum number of pre-flight maneuvers before

the spacecraft moves to its launching pad. Mating, assembly, tests and checkout would be performed off the launch site. Result? Between 100 and 150 days would be cut to hours/days of days or weeks.

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## NEW AEROSPACE PRODUCTS

### Airport Limp

Airport approach and field-of-view  
Quadrant lamp has approximately 18  
times the life of present lamps being  
used for that purpose; the manufacturer  
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Extended life is due to a 500-w, 20-amp Quartermore lamp mounted within a sealed-beam bulb at the focal point of its parabolic reflector. Quartermore lamp has an "iodine cycle" which renews evaporating tungsten to the filament preventing the inner wall from darkening with age and extending its life.

Lamp is available in a spotlight version with a stepped lens for flood narrow lighting and a spread lens to throw a precise rectangular beam for approach lighting. Units replace three of the cone wattage.

General Electric, Large Lamp Dept.,  
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## Mike West

Explosion-proof mineral electric hoist designed for waste handling applications has 125 ft. lift and 20-ton capacity.



Blow frame is welded steel, bearings are anti-friction type; and motor, basket, controls, pushbuttons and accessories etc.

traffic equipment are expensive, proof by Underwriters' Class 1, Group D special criteria. Most a random traffic design with one motor design tool.

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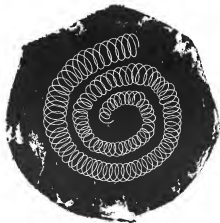
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Journal of Internal Medicine 247: 395–402

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**Said Svante Arrhenius:** "The change of the logarithm of a chemical reaction rate constant with respect to temperature, is inversely proportional to the square of the absolute temperature."

The aerospace industry is searching constantly for strong, light-weight, heat-resistant materials. Finally spun glass fiber, bonded with a plastic binder, is beginning to exhibit superior properties. Until recently the glass fiber has been far more heat-resistant than any binder.

Scientists at Lockheed Missiles & Space Company, however, have developed a compatible binder. This new makes it necessary for the glass-producing industry to evolve a glass to match its superior heat-resistance.

Compatible successes are being achieved in dozens of disciplines in which Lockheed is engaged. As Systems Manager for the DISCOVERER 1904s and other satellites and the POLARIS RM, Lockheed probes all areas of aerospace endeavor.

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a frequency response as high as 5 Mc and an acceleration range to 10,000g. Model 520 TX has holes for three-point mounting and Model 522 TX is slightly larger with a center clearance hole for single mounting.

Electrical isolation of shock sensor from mounting block insures no ground loop problems while mechanical isolation eliminates spurious signals from external forces, the manufacturer says.

Colson Research Laboratories, MacDade Blvd and Bellvue Lane, Woodbury, Pa.

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Table, Model 61A, is a portable, single degree of freedom, angular-motion producing device for evaluation of g's, accelerations, and small-ged area payload.



Device can test these systems with only an 800-watt amplifier. Angular displacement of  $\pm 15$  deg. with a maximum rate of 180 deg. per sec. Maximum acceleration is 10,000 g's. per sec. Model 61A includes test table and DC servo power amplifier.

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Specifications include max. degree per cent gun, input impedance of 700,000 ohms, natural frequency greater than 25 cps, at no load, frequency greater than 15 cps at 25 % load, threshold is less than 0.005 g's and less than 0.003 g's/sec.

Mass Cos Products, Inc., 505 S. San Francisco Blvd., Berkeley, Calif.



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